FOURTH BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR OF OREGON

FOR THE PERIOD

Beginning December 1, 1910
Ending November 30, 1912

JOHN H. LEWIS
State Engineer

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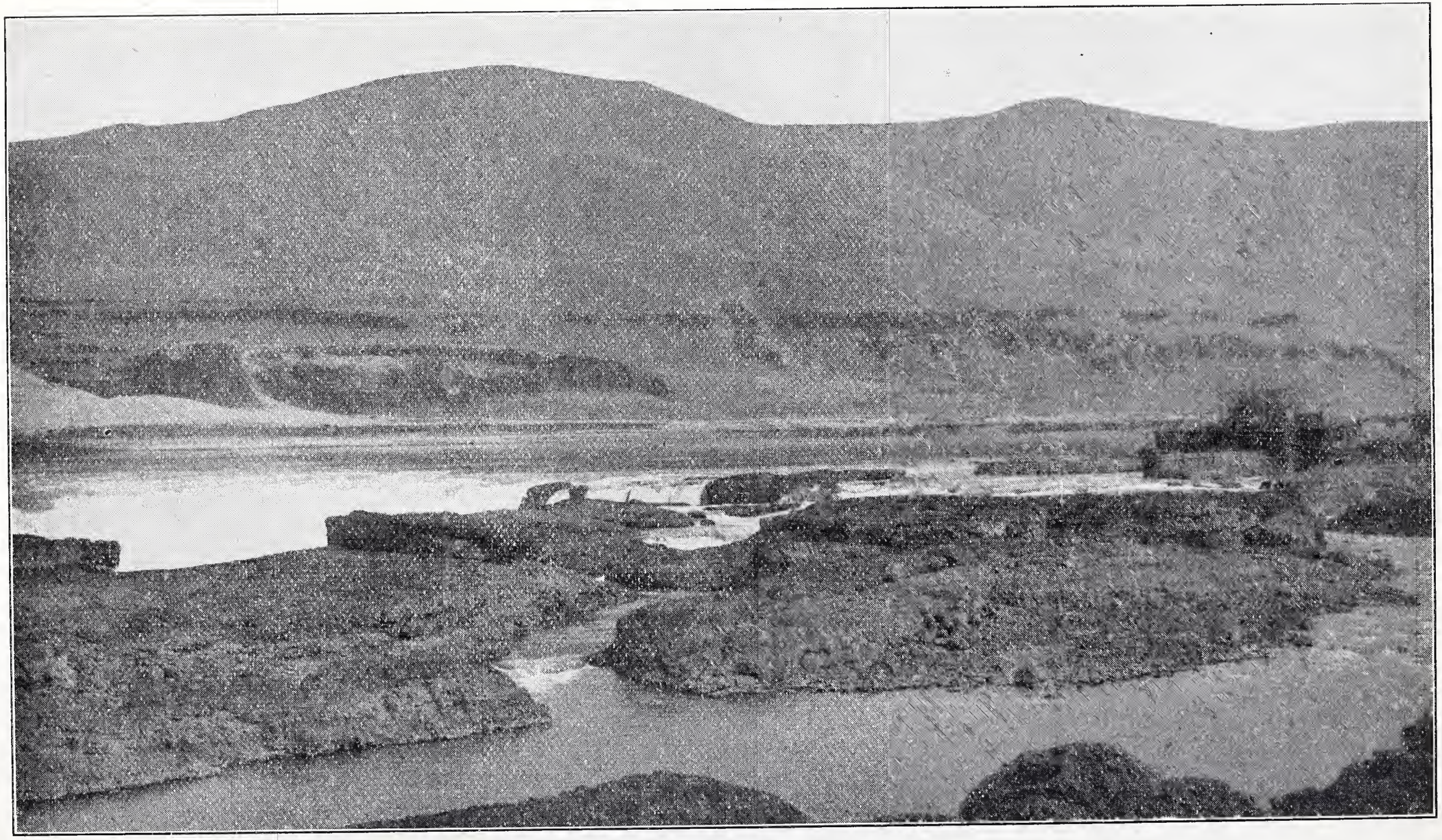
LETTER OF TRANSMITTAL

SALEM, OREGON, November 30, 1912.

To His Excellency,
Honorable Oswald West, Governor of Oregon:

DEAR SIR: I have the honor to transmit herewith, in compliance with law, a full report of the work of the office of State Engineer, including a statement of receipts and disbursements, for the biennial period ending November 30, 1912, together with such recommendations for legislation as are deemed advisable.

Respectfully submitted,
(Signed) JOHN H. LEWIS,
State Engineer.



CELILO FALLS IN THE COLUMBIA RIVER — TO BE COMPLETELY DROWNED OUT BY THE CONSTRUCTION OF THE PROPOSED POWER PROJECT, 6½ MILES BELOW.

FOURTH BIENNIAL REPORT

OF THE

STATE ENGINEER

INTRODUCTION.

The work of the State Engineer has to do with the water resources of the State. The State Engineer's office is the central office of record for all water titles. In time, this office should become a leading factor in the State's development, as in three-fourths of our territory water titles are of more importance than land titles. This office was first created in May, 1905.

The State Engineer is at the head of the State's administrative system charged with the determination and recording of those water rights which were initiated under the old law, and the protection of all such rights when determined.

He is directly charged with the granting of permits for new diversions, and must determine in each case whether or not such contemplated appropriations will menace the safety or the welfare of the public.

He is secretary of the Desert Land Board, which has charge of the reclamation of lands by the State under the provisions of the Carey Act. In this capacity he is responsible for the detailed correspondence of the Board with reference to the reclamation and settlement of over 500,000 acres of arid land.

He represents the State in the making of stream surveys, the making of topographic maps, and water power investigations in co-operation with the United States.

OPINION OF U. S. COURT.

With reference to this system of water titles, Judge Bean, of the United States District Court for Oregon, said in a recent case, that "I am impressed with the soundness of the view that a proceeding for the adjudication and determination of the rights to the use of the waters within the State, instituted and conducted as provided in the legislative act of 1909, is in effect a proceeding on behalf of the State through an administrative or executive board to have judicially settled *in an economical and practical way*, the rights of various claimants to the use of the waters of a stream or source of supply, and thus avoid the uncertainty as to water titles and the long and vexatious controversies concerning the same which have

heretofore greatly retarded the material development of the State."

SYSTEM INCOMPLETE.

Oregon is fortunate in having one of the most harmonious and complete system of laws relating to water, to be found in any state in the Union.

The information so far collected and the experience gained under this system, indicates that there is yet one more step to be taken, if those of us now living in Oregon are to receive any material benefit through the development of our wonderful water resources. Fortunately, the development and use of this resource by those now living in Oregon will not menace, but will, on the contrary, be a benefit to posterity, if water power franchises are limited to a reasonable period, for the experience of this generation will be a valuable guide for the next. Furthermore, the use of water does not lessen the available supply, like coal, wood, or other fuel resources.

The various steps so far taken to promote development in Oregon, will be outlined before presenting what is believed to be the next logical step in this campaign. If the present system is maintained with adequate appropriations for a number of years, we will know definitely:

1. The total quantity of water available in the principal streams of our State.
2. How much of this water is already vested, and rights to which are being protected by the State, and
3. How much of the surplus water is available for direct diversion and how much for winter storage.

For water power development, we must know not only the amount of water but also the available fall. For irrigation, we must know the location, extent, relative elevation of the land with respect to the available water supply; and for domestic, manufacturing or other uses of water, we must know something of the suitability of water for these purposes.

The State has provided reasonable appropriations for general investigations along these lines. It is not thought advisable at this time to recommend any increase, although it will take 38 years to complete the topographic map for the entire State, and four years to complete the Willamette Valley, at the present rate of progress.

On a few streams, such as the Deschutes, John Day, Umatilla, Malheur, Owyhee, and Silvies Rivers, we have now stream flow records of sufficient duration to warrant the investment of capital on an extensive scale. For the Columbia River, at The Dalles, we have a reliable record of stream flow extending over a period of 33 years.

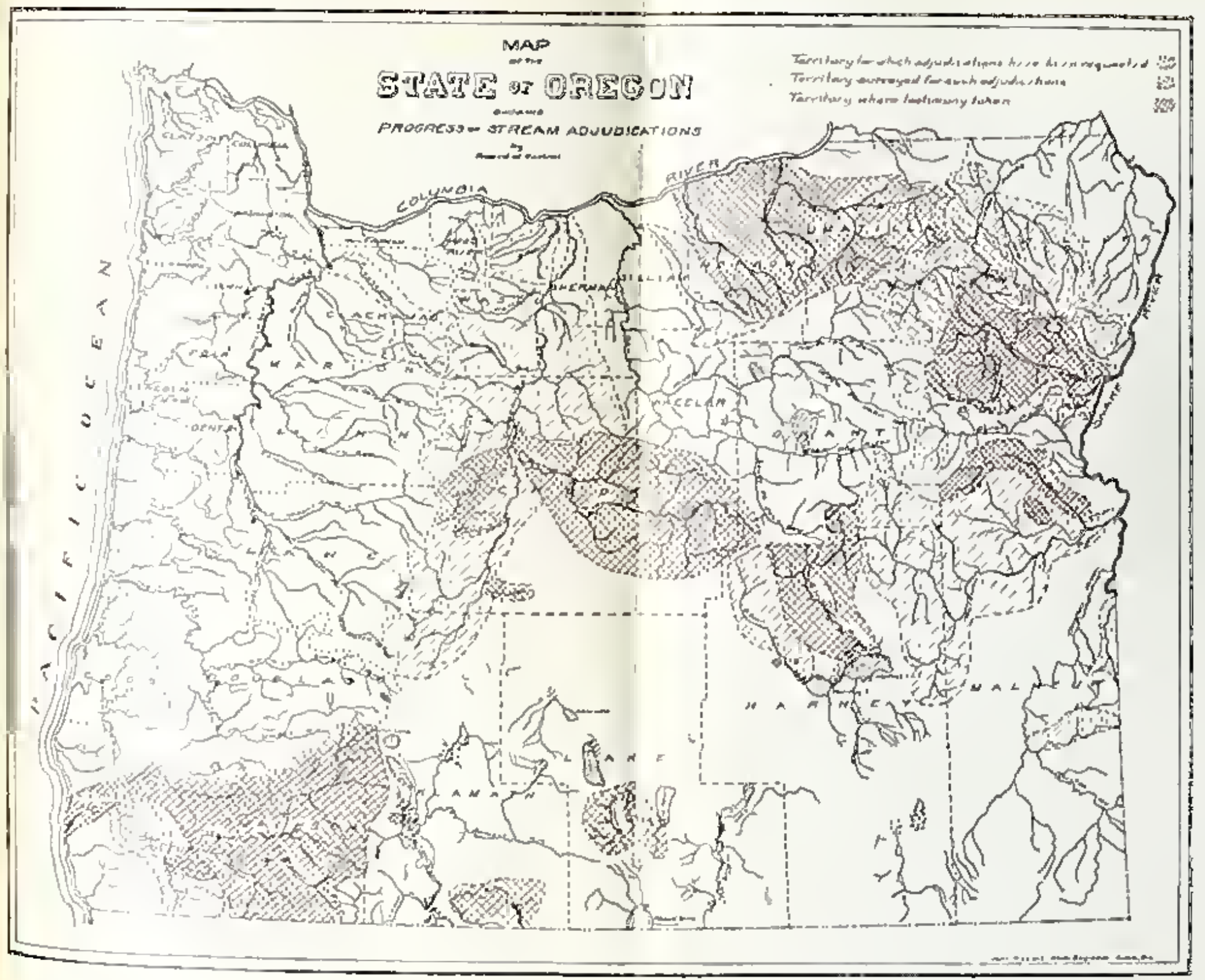


FIG. 1. SHOWS PROGRESS OF WATER RIGHT ADJUDICATIONS

All engineers agree that actual records of stream flow must be available for a long period of years as a proper basis for the investment of either private or public funds with safety, in irrigation and power projects. Therefore, this information must be gathered at public expense, as it is beyond the province of private capital to await for five or ten years, the collection of information before making an investment. The United States is now contributing dollar for dollar on most of this work, and the fees paid in the granting of water permits, and in connection with the adjudication of old rights, makes such department of the work nearly self-supporting.

LARGE PROJECTS.

We have in Oregon many large irrigation and power projects, which have been discovered in the collection of this general information, but which are beyond the reach of private capital. These large projects while somewhat complicated, are almost invariably the cheapest in unit cost, and should be taken up before the more expensive smaller projects. In some cases such as on the Deschutes River, the construction of these smaller projects will seriously complicate, if not ultimately defeat, the larger project. The same is true of a power project on the Columbia River, near The Dalles. A small project with a low dam constructed at Cascade Locks, will at the low water stage, destroy almost an equal amount of head at the upper and more important site, if complete plans for the maximum development of both sites are not in mind when the lower project is built.

To secure topographic maps, diamond drill borings at dam sites and other information necessary for determining the feasibility of such a project involves the expenditure of considerable time and money. Few promoters or capitalists care to make heavy investments to determine the feasibility of large projects which will require years to complete, even if they can be successfully organized after getting the information.

Under the present system, such projects are partially investigated by many different parties before finally being undertaken. Each party guards well the limited information he has collected in the hope of selling it to some one else. Unless the company finally undertaking the work has had wide experience in such matters, the project is liable to fail for lack of thorough investigation at the outset.

It is easy now to look back and criticize the land policy which our State has pursued in the past. A few dollars invested at the outset in the survey and appraisal of each tract

of State land, would have made possible its sale, at a price commensurate with its true value, instead of selling all at the minimum price as has been the practice. Such an enlightened policy would have greatly augmented our present school funds.

The next generation may have just as good ground to criticize the water policy pursued by this generation unless more detailed information is secured as a basis for the framing of a comprehensive water policy.

NEXT LOGICAL STEP.

If Oregon has within her borders, some of the largest and cheapest water power and irrigation projects in the west, it is the duty of the State to definitely ascertain and publish such facts, for the information of the world. This will require money, but in the end it is believed such information can be secured without cost to the public, and indirectly to its great benefit, if the following plan is adopted.

The investment by the State in such detailed investigations can be fully protected, and be made practically a lien upon the district to be benefitted through the withdrawal of the necessary water from general appropriation under the water laws of the State.

The publication of detailed plans and reliable estimates of cost, will make it possible for private capital in all parts of the world to figure upon the project without expense, thus stimulating competition. The water rights can be assigned to the one offering to carry out the State plan upon the most favorable terms, after the State has been reimbursed for the full cost of surveys and necessary promotion expenses.

If private capital cannot be found to carry such projects to completion, then full information will be available for the public in considering the advisability of undertaking such projects with public funds.

For the Columbia River power project near the The Dalles, very complete engineering data has been available for years, but no one has, up to the present time, collected and compiled this information in such a way as to bring out the fundamental questions of cost and feasibility. In fact, the opinion has prevailed that such project is not feasible, when in fact it is perhaps one of the largest, and cheapest power projects in the world. This information, costing thousands of dollars, was found scattered through the reports of various departments, and in some cases, unpublished. In such form it is practically worthless. It would seem the proper province of the State to

compile, digest, and publish this information in such a way that the lay mind can understand the extent of feasibility. In other words, to say what it will cost per horsepower year to furnish power from this source.

With definite information on specific projects we may find that our present irrigation and water power policies are not the best, and that some new policy would prove of greater benefit to the public.

After years of patient work in the collection of water supply data, the making of river profiles, topographic maps, and the collection of other general information, it does not appear logical for the State to stop at this point, when without cost,

DAM SITE IN THE DESCHUTES RIVER ABOVE CLINE FALLS.

all such information could be analyzed for specific projects and presented in such a comprehensive way that the general public could make use of it. What the farmer on dry land wants to know is, how to get the water and how much it will cost per acre. What the financier wants to know is, what does the project cost per acre, what can the farmer afford to pay, and how long will his capital be tied up in the enterprise to secure certain fixed profits. The public needs this information to ascertain what is a reasonable profit to pay for such development. One searching investigation going into all possible alternative schemes is all that is necessary to satisfy all these various interests.

Only the most feasible irrigation and power projects should be thus examined at the outset, and these investigations should be confined to those large and complicated projects which are beyond the reach of private capital. When these are finally organized for construction, the money returned could go into a revolving fund for the examination of other projects, as long as the public cared to continue such policy.

It is entirely proper that the district benefitted by detailed surveys and investigations should ultimately pay the cost. Unless some such plan is adopted, our large projects can never be organized and carried out by public or private funds. Take for example the Malheur Owyhee Project. Several earnest attempts have been made at great expense to organize this project, once by the United States, and many times by private capital. The actual land owners are as yet almost entirely in the dark as to detailed plans, or unit prices. For the protection of the Reclamation Fund, the detailed information collected by the Government is not given to the public. If purchased by some private promotor, it would still be unavailable to the land owner who is anxious for exact and thorough information so as to determine whether or not to sign up his land at the price offered. He is not competent and cannot afford to thoroughly investigate for himself all phases of the proposed project, and being naturally suspicious of promotors and stock companies organized for profit, he refuses to act on their information and advice. The result is a distinct loss to the community and State, through the failure of such interests to get together.

The recent failure by private capital to get owners in this district to sign up their lands for a proposed irrigation project, after making quite extensive surveys, duplicating much of the government work, will probably discourage for years any further attempts along this line unless the State comes to the assistance of the land owners. The State needs no better security for its investment in detailed plans, than to withold the water necessary for carrying such plans to completion until its money is returned. Every feasible project in the State will, and should eventually be built. The people in each local district can be depended upon to find some way to carry out the project, once they have complete and reliable information. Their own prosperity depends upon the fulfillment of the scheme, and the prosperity of the State at large depends upon making it possible for such communities to get such information.

Detailed topographic maps of Silvies River Reservoir site and the irrigable lands below, have been prepared by the

Reclamation Service, but are withheld from the public, in the hope that some interested land owners or promotion company may purchase them, thus reimbursing the Reclamation Fund. The reservoir site and portions of the land have been roughly surveyed by others since that time. Similar data exists for the Umatilla River and numerous Central Oregon schemes. The government officials could doubtless be persuaded to make any of this information public if the State would agree to withdraw surplus water and finish the investigations so that a complete plant for the highest use of each stream could be prepared, and thereafter permit development only along approved lines, after reimbursing the State and the United States.

By following some definite policy as outlined above, it is believed that some positive results could be accomplished in the near future, in the development of our large and complicated projects. As it is, the public interest cannot be wisely protected, and the best public policy to be pursued cannot be ascertained, for lack of information. We are all groping in the dark on the water power question. The public has no information as to what it will cost per horsepower year to develop power at different points, what it will cost to transmit power from such points to centers of population, what it costs to distribute power to consumers, or what is a reasonable profit above such cost to allow private capital for furnishing this service. Furthermore, the public knows little as to prices various industries can afford to pay for electrical power. There is thus no definite information upon which to base an opinion as to the proper policy for the State to pursue.

In order to demonstrate the value to the public, in compiling and digesting available information, two reports have been prepared and will be issued separately. One of these is for an extensive irrigation and power project, the other for purely a power project. These reports, while giving only approximate plans, and estimates of cost, will be sufficient to illustrate the value of final studies, based upon full information. They should, however, prove a valuable guide in the adoption by the State of a proper irrigation and water power policy. Before discussing such policy, and outlining the extent of these reports, the general plan for collecting such information will be presented.

METHOD OF SECURING INFORMATION.

Two methods can be followed in collecting and digesting information as to our land and water resources.

1. By the State in co-operation with the United States, or
2. By the State acting alone.

Of these two, the first appears most desirable for many reasons. The United States will probably contribute dollar for dollar with the State in such work. In fact, the Secretary of the Interior has already informed the Governor and the Oregon Conservation Commission that he will recommend to the President the allotment of $50,000 for the investigation of the Deschutes Irrigation Project which involves also the development of a large amount of incidental water power, if the State of Oregon will contribute an equal amount of money.

The resulting plans and estimates will probably be given greater weight by private capital, or by the public, if passed upon by the government's board of consulting engineers familiar with conditions in many states, than if passed upon by local engineers.

The United States has better facilities for publishing complicated maps and at considerable less cost than could be accomplished by the State.

Co-operation would save the State much loss of time in preparing an organization, getting out new forms, instructions, etc., and in planning a new system for handling the work. It will furnish stability to the plan by preventing each new state co-operating officer, in carrying out his own individual ideas, regardless as to whether or not they are an improvement on existing methods; and it would avoid troublesome questions of politics, patronage, etc.

The State appropriation should not be made absolutely contingent upon the appropriation of the United States, and should be somewhat in excess of the government allotment. The U. S. Reclamation Service is limited to the investigation of only those water power projects which are incidental to reclamation development. It could not co-operate therefore, in a purely water power development, or some other project that might prove invaluable to the State. The State should in the near future get detailed information as to the cost of development of three different water power projects, whether or not any irrigation is incidental, also the cost of distribution to centers of population in the vicinity of Portland, one in the Blue or Wallowa Mountains, and one in Southern Oregon. Transmission lines of reasonable length could be built from such plants to all parts of the State if found desirable.

These investigations should be thorough, including all details, and passed upon by a competent board of engineers, so that private capital in all parts of the world, and the public generally, may know whether any advantage can be had from the development of these water powers.

A brief outline of two projects worthy of thorough investigation by the public will here be presented.

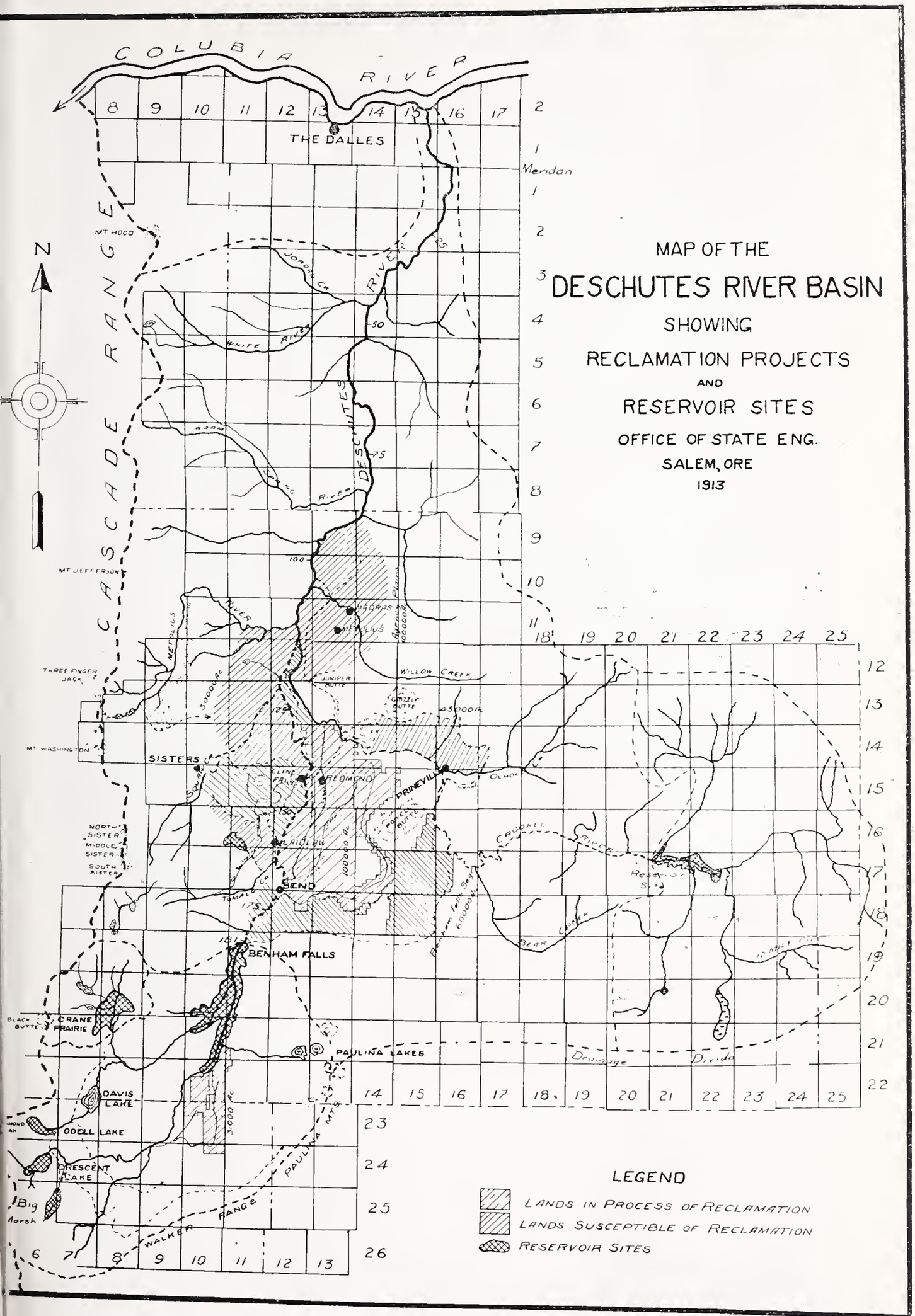


FIGURE 2—ONE OF MANY PROJECTS WHICH SHOULD BE INVESTIGATED BY THE STATE SO THAT PRIVATE OR PUBLIC FUNDS CAN BE ENLISTED IN ITS CONSTRUCTION.

DESCHUTES RIVER PROJECT.

The Deschutes River Basin, if properly handled, presents enormous possibilities for development. At the present time, approximately 65,000 acres are being irrigated, whereas over 500,000 acres can eventually be supplied if the situation is not complicated by power, railroads, or other conflicting interests. While much power will have to be sacrificed to carry out the irrigation program, yet approximately 800,000 horsepower can be developed on the Metolius, and the lower Deschutes Rivers. On most streams the use of water in the upper valleys for irrigation purposes generally benefits the lower portion of the stream for power development.

Only the general features of this project will be presented in this report, as a special detailed report will soon be completed by this office, in co-operation with the U. S. Geological Survey, and published early in 1913 by such Government Bureau.

By looking at the accompanying map of the Deschutes Basin, it will be noticed that power development will be confined almost exclusively to the lower third of the basin, irrigation to the middle third, and storage to the upper third, including the headwaters of the tributaries to the east and west of the irrigated section. The large tracts in process of reclamation, and the lands susceptible of reclamation, also the proposed reservoir sites, are shown on such map.

The relative elevations along the Deschutes, Metolius, and Crooked Rivers, in comparison with the Columbia, Snake, and other rivers with which we are familiar are shown in a separate cut. Every twenty-fifth mile from the mouth of the Deschutes is indicated both on the map, and the profile for convenience in comparison.

POWER.

From the mouth of the Metolius to the Columbia River, is 111 miles. In this distance there is a fall of 1,400 feet, or approximately 13 feet per mile. With 80,000 acre feet released at the proper time from a reservoir on Crooked River, 4,500 cubic feet per second can be depended upon at the mouth of the stream. As the streams flows through a deep rock walled canyon, conditions are favorable to the construction of a dam at almost any point, so that every foot of this total fall can eventually be utilized, producing approximately 600,000 horsepower.

It is 48 miles from Blue Lake to the mouth of the Metolius River, in which distance there is a total fall of 1,900 feet, or

approximately 40 feet per mile. While conditions are not so favorable for the construction of dams, yet it is believed that when the detailed studies are finished, about 200,000 horsepower can be developed on this stream.

The total of 800,000 is more than can be developed at Niagara Falls, when all the water allowed under the present treaty with Canada is fully utilized.

On Tumalo Creek there is 1,500 feet fall in the 12 miles above the proposed low line diversion to the Wimer Reservoir site where the surplus waters of this stream should be stored for irrigation purposes. The minimum flow of about 100 second feet, together with this fall, should supply all the power needed for many years to come in this upper district where power possibilities in the Deschutes should be destroyed in favor of irrigation.

Between Benham Falls and the mouth of the Metolius River, 2,600 feet of fall will be destroyed for power purposes in a distance of 70 miles. In this section diversions are possible for irrigation, and there is more land which should be irrigated, than there is water to supply.

IRRIGATION.

The direct flow of the Deschutes River supplemented by storage above Bend, will be sufficient to irrigate 210,000 acres in the district between Bend, Prineville, and Madras, and Sisters, in addition to the 100,000 acres which is now in process of reclamation, allowing sufficient water for the irrigation of 80,000 acres in Walker Basin, above Benham Falls.

Tumalo Creek, if regulated, should irrigate 30,000 acres, Crooked River 50,000 acres in addition to the 22,000 acres now supplied. By carrying water to be stored in Blue and Suttles Lakes in a canal to the south of Black Butte, about 10,000 acres can be irrigated from the head waters of the Metolius River.

STORAGE.

A dam at the head of Benham Falls, raising the water 65 feet will create a lake 20 miles in length, flood 25,000 acres and store 700,000 acre feet of water. The balance of the 1,053,000 acre feet available at this point, can be diverted directly from the stream during the summer without storage.

Odell and Crescent Lakes and Big Marsh, together with the regular flow of the West Fork of the Deschutes River, diverted just below the proposed Crane Prairie reservoir site, can be relied upon to furnish the 240,000 acre feet of water reserved

in this plan for the irrigation of 80,000 acres in the upper valley.

This ideal natural reservoir site may be destroyed if the railroad is constructed southward from Bend, its present terminus, as for about 15 miles it is located within the area to be flooded.

A dam at the forks of Crooked River, 170 feet high, will store 360,000 acre feet, thus equalizing the flow between wet and dry years, and make available 80,000 acre feet for power and 150,000 acre feet for the irrigation of 50,000 acres along Crooked River.

CROOKED RIVER AT SMITH'S ROCK.

PLAN OF DEVELOPMENT.

Every drop of water in the Deschutes River Basin comprising 9,180 square miles, can and will eventually be put to beneficial use if some comprehensive plan of development is followed. If the development of this stream is left to private capital without any regard for public interest, enormous waste will take place before the highest use of these waters is attained. For immediate gain, small and relatively expensive reservoirs will be built where a few large reservoirs can be made to serve all purposes. Power plants will be built at points where all the water should be diverted or stored for irrigation purposes. Power plants on the lower river may attempt to

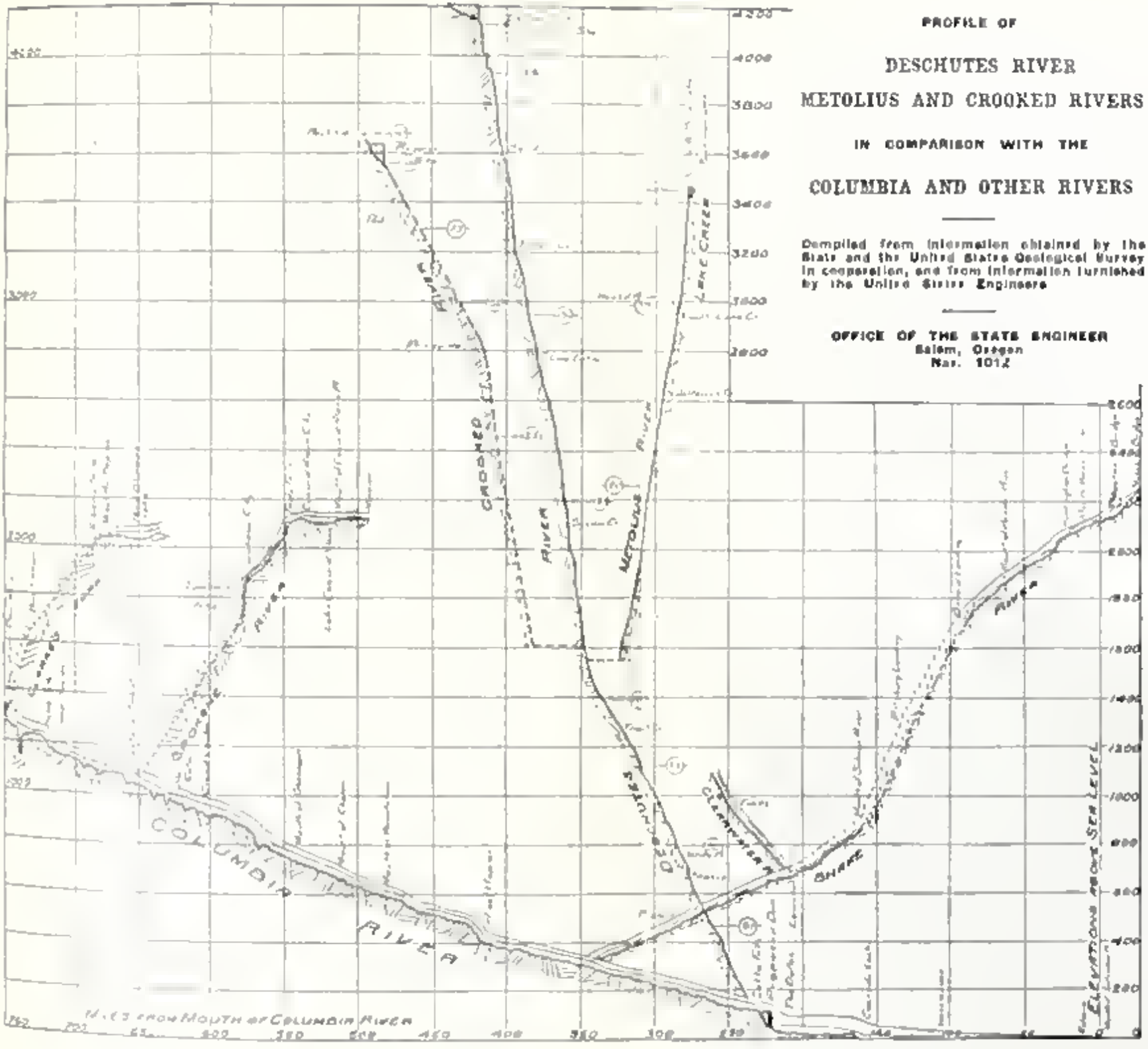


FIGURE 3—PROFILE TO ACCOMPANY FIGURE 2.

secure such vested rights as will not permit the subsequent storage or diversion of water at points above for irrigation, when in fact the return seepage from such diversions, if permitted, would probably benefit, rather than injure such power development. Storage to supplement the flow of water in the lower river for power purposes should not be permitted on the Deschutes River above Bend, but should be confined to Crooked River, from which stream the diversion of water for irrigating more than 50,000 acres of land is about twice as expensive as from the Deschutes River. With this exception, every drop of water in the middle and upper third of the Deschutes River Basin should be reserved for irrigation purposes and power possibilities destroyed to this extent, for irrigation possibilities within the State are extremely limited and our supply of undeveloped water power is probably far beyond the needs of the present generation. To make possible the highest use of the Deschutes River, we must prevent the construction of the railroad where located south of Bend, as for fifteen miles it passes through the Benham Falls Reservoir site where at but little if any greater expense, it could be located a little farther to the east, and above the proposed water level. All of these matters are believed to be within the control of the public if a comprehensive plan of development is adopted and subsequently adhered to and enforced.

COLUMBIA RIVER POWER PROJECT.

It is believed that the largest, and perhaps the cheapest water power project in the world is located in the Columbia River, near The Dalles, Oregon. While this project may not be the cheapest per unit cost of construction for large projects, yet when it is remembered that it has competing transcontinental railway lines on either side of the plant, with navigable water from the foot of the power house to the Pacific Ocean, and for many miles inland, and is within easy reach of the power market of the Northwest, it is believed that owing to the facility with which raw products can be transported to and from establishments to use such power, that it is, by virtue of its accessibility, perhaps the cheapest undeveloped power in the world of such magnitude.

The establishment of this fact should mean much to the Pacific Northwest. Its construction, together with the use of such power, would produce large quantities of rail and water freight to all parts of the world. Great docks, and expensive canals are of no particular value unless we have freight requiring their use in reaching the markets of the world.

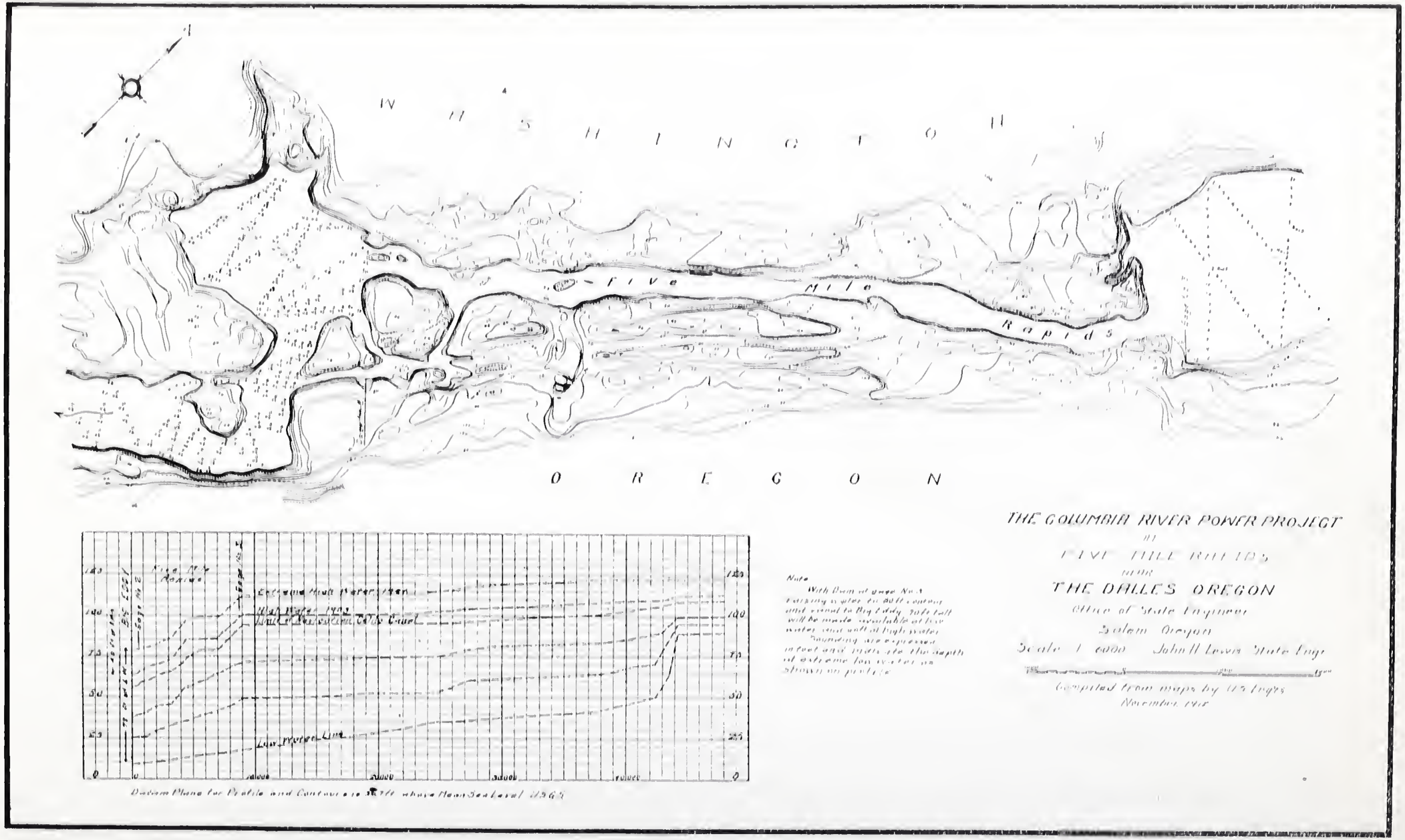


FIG. 4.—SHOWS TOPOGRAPHY FROM BIG EDDY TO PROPOSED DAM SITE, ALSO PROFILE OF RIVER FROM BIG EDDY TO A POINT 4,000 FEET ABOVE CELILO FALLS.

The construction of this power plant will not destroy a water fall of great scenic beauty, but will, on the contrary, create one which at the low stage of the river will equal one-half the height of Niagara Falls.

It will involve the absolute control of a mighty river, carrying at low stage ten times the low water flow of the Willamette at Oregon City, and 28 times this amount during extreme floods, and at a point where there is a natural fluctuation of 90 feet between low and high water.

The dam and controlling works will be located at the head of Five Mile Rapids, from which point a canal 300 feet wide and approximately 20 feet deep will be excavated in solid rock, on the Washington shore for a distance of 1½ miles to Big Eddy, where a fall of 74 feet can be secured at low water. For a short time during high water this fall will be reduced to about 33 feet. A minimum head of 42 feet can be depended upon at all times, except when floods exceed 1,000,000 cubic feet per second, or about two months in 33 years. To utilize the fluctuation of head water during floods, an immense wall in some places 50 feet or more in height, must be constructed on the lower side of this canal, and a low wall in some places on the upper side is required to keep the water from flooding the North Bank Railroad. About six miles of railroad on both banks of the stream will have to be elevated. The back water from the dam will completely drown out Celilo Falls also, 6½ miles of the Celilo Canal, thus making it useless.

The drainage area of the Columbia, at The Dalles, is 236,800 square miles and at its mouth, 259,000 square miles, in comparison with 135,000 square miles for the Mississippi River at Quincy, Illinois, and 1,259,000 square miles at its mouth.

The Columbia River at The Dalles has a mean annual flow of 235,000 second feet in comparison with about 73,000 near Keokuk, 222,000 at Niagara, 664,000 at the mouth of the Mississippi, and 115,800 for the Nile.

A thirty-three year record shows the low water flow of the Columbia at The Dalles, to be 50,000 second feet, during the winter months in comparison with 20,000 second feet the minimum flow at the large Keokuk development on the Mississippi, the maximum flow at such plant being 200,000 second feet, in comparison with 1,390,000 for the Columbia.

Under these conditions of water and head, 330,000 turbine horsepower of 300,000 electrical horsepower can be depended upon, except for flood stages of over 1,000,000 second feet. It is believed that this slight difficulty can be overcome by improvements in turbine design, or other modifications in the

plan. This project, if constructed, will be by far the largest water power project in the world.

It is claimed that the power plant at Rjukan, Norway, of 140,000 horsepower is the largest completed development under one roof.

On the Mississippi near Keokuk, Iowa, it is expected that the largest water power project in the world will be completed by January 1, 1913. This project involves the construction of a dam 53 feet in total height, nine-tenths of a mile in length, and the control of the Mississippi floods by operating 119 gates 32 feet wide by 11 feet high, fitted between piers, and on top of a concrete spillway which is 32 feet above the river bed. While the water will be maintained at a constant level above the dam, the operating head will vary from 39 feet to 21 feet, according to the stage of the river below the dam.

The power house will be 133 feet wide, 177 feet in height from foundation to roof, and approximately one-third of a mile long. It will deliver 200,000 continuous horsepower at a cost of $125 per E. H. P., and contain 30 turbines. During certain stages of the stream, a much larger quantity of power can be developed.

It has been estimated that the Columbia River power plant can be constructed for $23,076,000 or $77 per horsepower on the basis of 300,000 delivered horsepower, or only 62% of the Keokuk cost. The estimated cost of power delivered at the low tension bus bars of the generating station is $.89 per horsepower per annum for continuous 24 hour power throughout the year.

For eight months of the year the above plant can furnish without additional cost or expense other than the wear on the machines, 236,000 additional horsepower which, if not useful for any other purpose could be furnished at only the cost of distribution and transmission to Portland, Vancouver, The Dalles, and other towns for heating purposes, just as is now being done on the Minidoka Project of the U. S. Reclamation Service. By installing additional equipment, as much as 1,000,000 horsepower could be developed for nearly five months of the year with a construction cost of about $35 per horsepower and at an annual cost per horsepower delivered, of only about $4.50 per horsepower year.

To enclose the 21 turbines, which it is proposed to install near The Dalles, will require a power house 1,200 feet in length and approximately 200 feet in height from the foundations. One of these turbines will be maintained for emergency use.

To give some idea as to the magnitude of these turbines, it

can be said that each turbine can pass 5,000 second feet of water at maximum flow, which is about equal to the entire low water flow of the Willamette River near Oregon City. The turbine runner will be 16 feet in diameter at the band, and attached to a vertical shaft about 30 inches in diameter and 60 feet long on the top of which will be attached the electric generator approximately 36 feet in diameter, and all of which will revolve at the rate of about 80 revolutions per minute on a single bearing. Oil will be pumped under great pressure into cavities in this bearing so that the whole mass will practically float, and revolve on a film of oil. Each turbine will have a maximum capacity of about 32,000 horsepower.

The most difficult features to be encountered in this proposed power project will be to construct a dam approximately 170 feet in height across the narrow gorge at the head of Five Mile Rapids completely closing the present channel of the river, and to regulate the extreme floods so as not to materially affect high water conditions in the Columbia above the dam. It is proposed to accomplish this task by constructing a bypass approximately 1,400 feet in width through solid rock around the proposed dam site, through which the stream at all stages will be diverted. Across this artificial channel will be located 14 sections of removable dam about 70 feet in height o fthe type which it is proposed to use as an emergency dam in the Panama Canal. This will consist of girders or steel beams which will be dropped from an overhead support to nearly a vertical position, fitting into a concrete shoulder at the bottom of the channel. Down the face of these beams will be rolled a steel curtain or steel gates. This will be rolled back and the girders hoisted entirely out of the water by means of a cable attached to the lower end, and all obstruction to the water removed when necessary during floods.

The accompanying cut shows the territory affected by the Keokuk and the proposed Columbia River projects respectively. While it is not likely that power will ever be transmitted 300 miles from such plant, yet this diagram shows the territory which could be served if no other more economical supply were available.

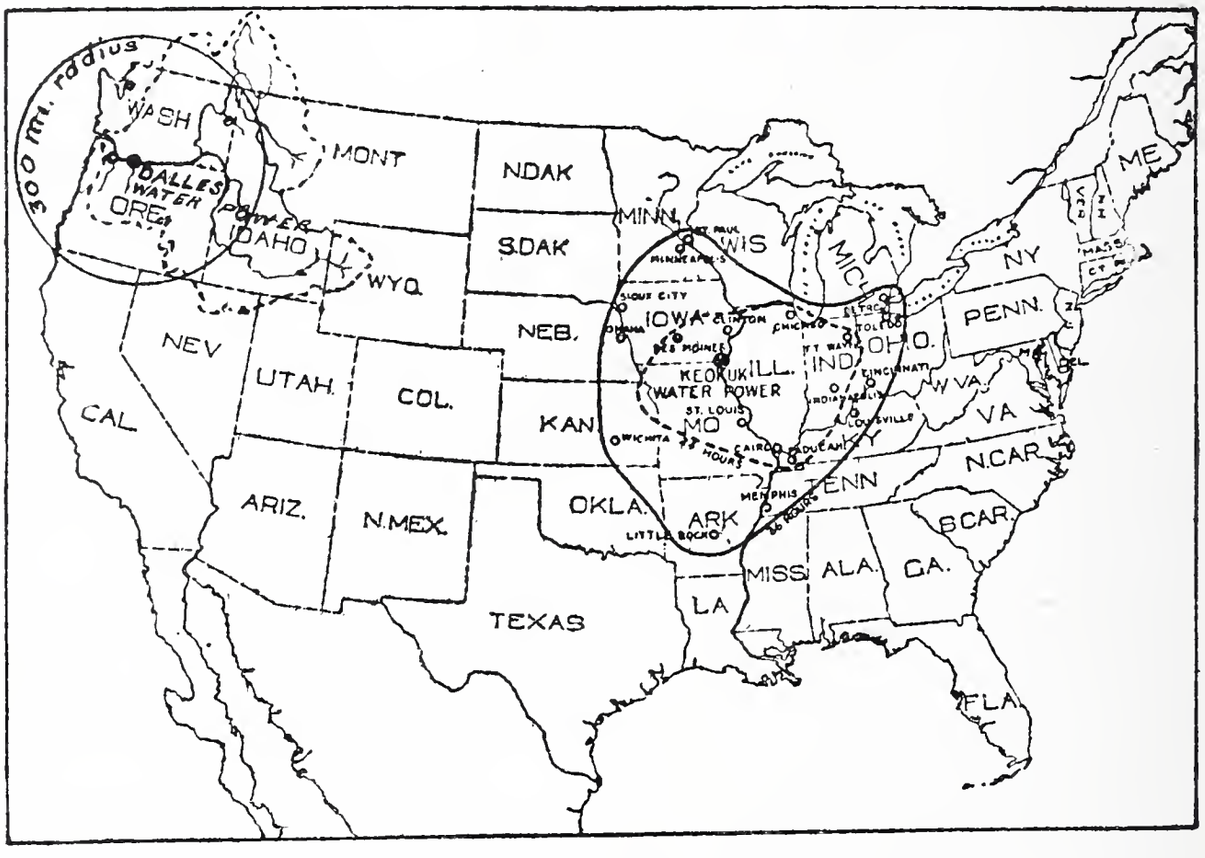


FIG. 5. TERRITORY AFFECTED BY THE MISSISSIPPI AND COLUMBIA RIVER POWER PROJECTS.

A full report of the Columbia River Power Project will be issued as a supplement to this report. I am indebted to L. F. Harza and V. H. Reineking, engineers, for working out, under my direction, the detailed technical features connected with this project.

NECESSITY FOR CO-OPERATION.

These two projects illustrate well the necessity for co-operation in detailed investigations.

In the Deschutes project both the State and the nation are interested. The State is supposed to control the water and a small amount of land while the United States owns a very large percentage of the land in the district. Through the ownership of a few tracts along the Deschutes River, the United States practically controls the water power policy within the district. 273,000 acres of this government land has been under contract for reclamation by the State under the Carey Act.

Part of these contracts will doubtless be successfully carried out, but the State has utterly failed so far to complete the 30,000 acre Columbia Southern project located on the west bank of the Deschutes River near Laidlaw. It is morally obligated to take some new step looking to the ultimate reclamation of this tract in order to save the payments by settlers on about 18,000 acres, a large part of which will revert to the United States if not irrigated in accordance with the State's contract. A majority of the land, however, is in private ownership only a small part of which is under cultivation by irrigation or dry farming methods. The State is vitally interested in the closer settlement of these lands, thus increasing its population and taxable wealth.

The Dalles power project is of interest, not only to Oregon, but also to the State of Washington, and to the United States. Oregon owns one-half the bed of this stream and Washington the other half. All of the water at this point cannot be appropriated under the laws of either State, as the Supreme Court has held that there must be an "equitable division of benefits" in the distribution of interstate streams. The United States, through its control of the navigability of this stream, practically controls the power project at this site. It may limit the power franchise to an unreasonable period, or impose such heavy annual taxes payable to the Federal treasury as to defeat development. It will be several hundred years before the demand for electric power at commercial rates for industries now established in Oregon will be sufficient to warrant the construction of so large a project. If this plant is to be constructed in the near future it can only be accomplished by furnishing power in large blocks at law prices to new industries not now established in Oregon.

The power from this plant, could, if necessary, be supplied at reasonable rates within a radius of 300 miles, which includes all of Oregon and Washington, a large part of Idaho, Vancouver, B. C., and a small amount of territory in Northern California. Within this radius there is probably much vacant government land which could be irrigated by pumping water if cheap power were available.

But few industries are so large as to warrant the construction of a plant far in excess of their requirements, in order to get cheap power.

These are only two of many projects which might be used to illustrate the point. They, however, are typical of most large projects within the State and should show clearly why private capital is far more interested in the smaller project of greater unit cost, than in the larger project of less unit cost.

Such small projects are more simple and easy to construct, and for public service corporations insure equal returns. For whatever the cost, reasonable returns on the investment must be allowed by a public service commission.

The overcoming of the human element in the organization of a large irrigation district is one of the most difficult tasks. It is the reason largely why the Government officials prefer to expend the reclamation fund in those arid states where but a small percentage of land is yet in private ownership. These difficulties being due to the early settlement of our lands, should in part, be overcome by the cooperation of the State if we are to expect the investment of Federal funds under the existing law, which does not require the return to the State of any part of the money contributed by it.

Because of the many complications, the large number of private and public interests involved, and the vast territory affected in the construction and operation of large irrigation and power projects, it is believed that cooperation between the State and the Nation in detailed investigations will either greatly stimulate development by private capital, or pave the way for cooperation in construction work.

Both the State and Federal funds expended on such investigations can be protected if desired by State water right withdrawals.

PUBLIC DEVELOPMENT.

If private capital cannot be interested in the construction of those large projects, the necessary information will be available so that the public can ascertain with some degree of certainty, whether the indirect benefit from development will offset the risk involved in loaning public funds for construction work.

As both State and Federal funds will be made a lien upon the projects constructed, and ultimately returned, it makes little difference whether the State or the United States advances the money except as to the risk incidental to failure, and the difference in interest rate at which State or Federal bonds can be sold. The only advantage in construction from the Reclamation Fund is the saving in interest charges.

The same arguments which apply to cooperation in the making of investigations apply equally to cooperation in construction work. Furthermore, if construction work is undertaken the average taxpayer will doubtless feel more certain that the money voted will be wisely expended and ultimately returned, if entrusted to a larger and more experienced and

FIGURE 6—SHOWS TERRITORY WITHIN REACH AT COMMERCIAL RATES, IF NO MORE ECONOMICAL POWER WERE AVAILABLE.

stable organization. If such large projects are constructed by these two agencies, it may be found advisable at a later date, when an experienced State organization has been developed, to cut loose from the National organization.

ADVANTAGES OF PUBLIC DEVELOPMENT.

The expenditure of large amounts of new capital in a state of limited population cannot fail to be of some benefit to every person within its borders.

Private capital has not, up to the present time, and probably will not in the future, undertake and carry out the construction of large irrigation and power projects with a view to the highest development of our resources, and the greatest good to the greatest number.

The reclamation of lands with public funds had the effect of greatly stimulating private irrigation.

The construction of large power projects with public funds, and the sale of power to new industries not now established in Oregon, should not be objectionable to private capital already invested, in power plants. There is no incentive for private capital to encourage the establishment of such new industries requiring large blocks of cheap power, for the reason that there can be but little, if any, profit in the business. The State, however, having enormous quantities of water power running to waste can, for the small indirect benefit and return to its citizens, afford to undertake such development. The public plant should, in each case, charge all the traffic will bear, but secure business in competition with other water powers throughout the world. For some uses the charge should be considerably above cost, for the iron and steel industry, for wood distillation plants, or for the application of electricity as heat, the charge should be approximately cost, and perhaps a little below if the comforts or indirect benefits from such uses are very great.

I can see no reason why the public should refuse to enter this field, as it is believed that the indirect benefits will equal, if not exceed, that obtained through the reclamation of arid lands. Owing to the ability of the State to borrow money more readily and at less interest than private capital, it may be able to make considerable profit, in addition to such indirect benefit. The enormous waste of power will at least be somewhat lessened, and future generations benefited by our experience.

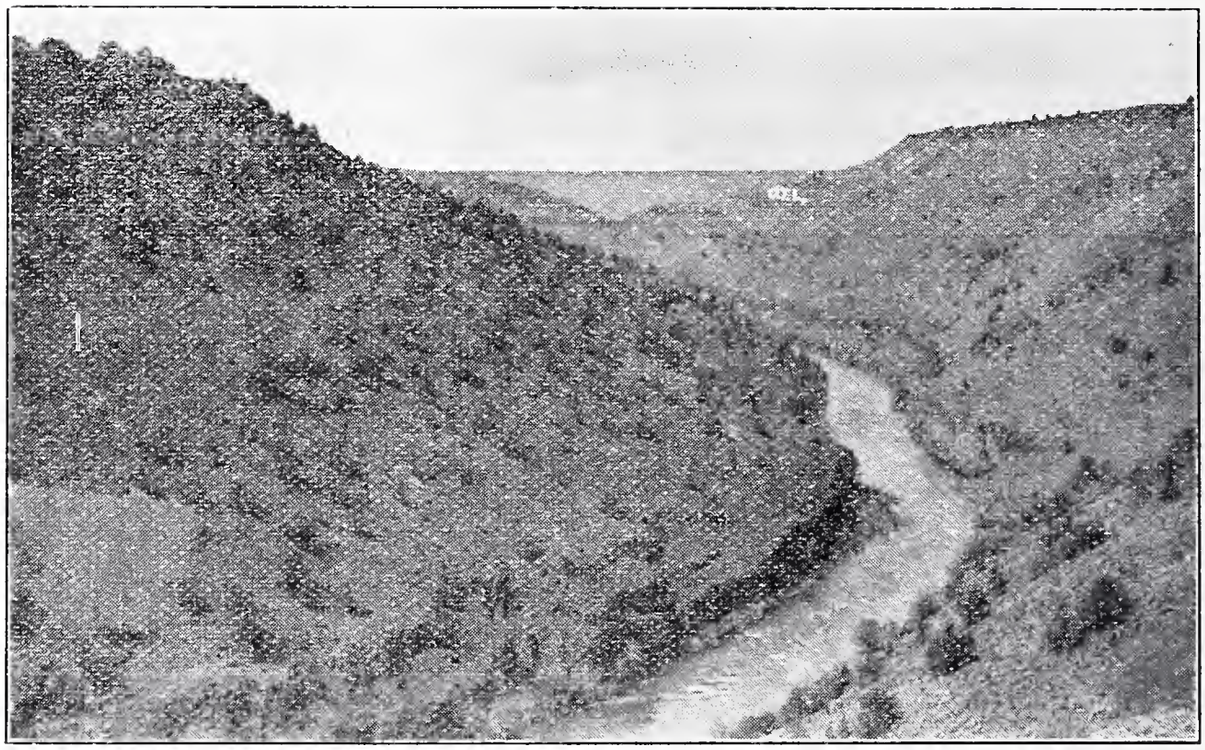
NEW INDUSTRIES.

Some of the new industries which could be established in Oregon, if large quantities of electrical power could be had at low cost are, as follows:

a—The electric reduction of iron and steel.

b—The wood distillation industry with charcoal for the iron industry obtained as a by-product after extracting wood alcohol, acetic and oxalic acid, wood oil, turpentine, creosote and acetate of lime, from our stumps and waste wood products of the mill.

c—The making of fertilizer from the air by the fixation of atmospheric nitrogen in the electric furnace.



DAM SITE ON THE DESCHUTES.

d—The manufacture of calcium carbide which is used extensively for lighting purposes, and also after further treatment producing cyanamid and used as fertilizer.

e—The making of alkali from salt by the electrolitic process.

f—The making of aluminum from bauxite.

g—The making of carborundum which is used extensively as an abrasive.

h—The making of graphite in the electric furnace, which is now taking the place of oil as a lubricant.

i—For the melting of concentrates.

j—For innumerable electrochemical processes.

k—For heat, light, and power, in the home, on the farm, in hotels, bakeries, factories of every description.

These various industries will be discussed somewhat in detail in order to give some idea as to the industrial development which will come to Oregon where the power, raw materials, and transportation facilities are available, if only our people make it possible for such industries to live. Cheap power is the key to the situation. Just as we now see that the high speculative values on irrigated lands are keeping settlers away, so is it all the more apparent that the lack of profit to private capital in supplying power to such industries is keeping away from Oregon far more capital, and depriving our laboring classes of profitable means of employment.

IRON AND STEEL.

The production of pig iron in the electric furnace is now a commercial success, according to Rudolph W. Van Norden, in the Journal of Electricity, Power and Gas, Nov. 23, 1912.

The latest type of furnace which has been developed after six years of experimental work at Heroult, Shasta County, California, has been in operation day and night, without interruption since September 5, 1912. Three times a day, six tons of high grade soft pig iron is tapped from it, or 18 tons per 24 hours. Two more furnaces of slightly greater capacity are now nearly completed, and it is intended to construct three more furnaces in the near future. The plant could then turn out over 100 tons of pig iron per day.

This furnace is simple and easy to operate. It consists of a box 27 feet long, 13 feet wide and 12 feet high, and lined with fire brick. The roof of the furnace is arched, and supports five stacks or tubes, 24 inches in diameter, 15 feet in height, between which the carbon electrodes are located. The electrodes are made of compressed carbon, 12 inches in diameter and four feet long. As they are consumed, they are forced downward into the charge with the aid of a jack-screw. Each electrode lasts about thirty days. The furnace is charged through the top of these five stacks.

A typical charge for this furnace consists of 500 pounds of iron ore (70% magnetite), 135 to 150 pounds of charcoal, 3½ pounds lime (well burned), 12½ pounds of quartz.

COST OF ELECTRIC SMELTING.

Pig iron has been produced at Heroult, California, in one of the experimental furnaces at $15 per ton. This was delivered in San Francisco at $18 where ordinary pig commanded from $23 to $26 according to T. H. Norton in an

unpublished report, dated October 16, 1911, obtained from the U. S. Department of Commerce and Labor. The ore used averaged 69.7% iron, limestone 98% pure, and coke cost from $10 to $13 per ton.

Mr. Norton describes the results of a six months practical test on a working scale of electric smelting in Sweden, and states that "The data furnished (in his report) on details of construction and operation, and on the technical and financial results are of fundamental importance for the future of the iron industry *wherever cheap electric power is available.* The vista which they open up to the metalurgical interests of Norway and Sweden, with their wealth of water power, is such that the iron industry of distant lands may feel the economic effect at an early day."

From the results of these experiments at Trollhattan, Mr. Norton states that the limit of the economic production in the smelting of iron ore by the electric method, in competition with the blast furnace process is as follows, for the varying prices of coke, and of electric power, and for varying yields of pig iron:

Yield in kilogrammes per hp. day.	*Coke, Price per Metric Ton.*			
	$ 4 00	$ 6 00	$ 8 00	
6	$ 5 12	$ 7 67	$10 25	Cost per E. H. P. year.
7	5 79	8 68	11 58	
8	6 40	9 60	12 80	
10	8 00	12 00	16 00	
12	9 00	13 50	18 00	

He states further "that the yield per horsepower day was about 7 kilogrammes of pig iron from 49% hematite. On the above scale, with coke at $4 per ton, it would be necessary to have current available at the rate of $5.79 per annum, in order to meet the competition on even terms.

"Electrical metallurgists, such as Heroult, are now very confident that when the new method is installed on a large scale, it would be feasible to attain a yield of 12 Kg. per horsepower day. Under such conditions current at $9.00 per horsepower year, or 0.14 cents per hour, could compete with $4.00 coke.

"There is much to encourage the belief that the actual expenditure of electric energy, per ton of pig iron produced, will in practice be steadily reduced.

"Under Swedish conditions an annual cost per Kw. year of $10.72 appears to be, for the present, the limit of economic production. This corresponds to 0.122 per Kw. hour.

"The general experience in the electric steel furnace in Germany shows that 4 E. H. P. hours of current possess the same thermal value as 1 Kg. of good coal; and hence electrical power at not over $8.00 per E. H. P. year can compete with good coal at not less than $4.00 per long ton."

There is much power in Oregon which can be developed and furnished in the vicinity of the plant within the limit of from $5.00 to $10.00 per horsepower per annum. Where the production of iron and steel is now impossible with coke at $12 per ton, the prevailing price for the best quality in Portland, it may become commercially profitable if the State would encourage the development and sale of electric power at the lowest possible cost.

"The Italian electrical engineer, Catain, calculates that with an output of 12 Kg. of pig iron per electric horsepower day, there is practically no difference in the cost of production between the present method and the electric process, *provided that the E. H. P. year costs the same as two metric tons of coke.*"

In American cities rates of 0.66—0.87 cents, per Kw. hour ($37 to $57 per horsepower year), for electricity generated by coal, costing from $2.14 to $2.44 per ton, are quoted. The standard rate at Niagara Falls is 0.5 cents, (or $32.85 per horsepower year), and some extensive electric plants supply large consumers at 0.3 cents (or $19.70 per horsepower year). It will probably be necessary in the United States, to secure electricity generated by cheap water power, at a rate of 0.2 cents per Kw. hour ($13.14 per horsepower year), or less, in order to warrant the installation of electric smelting furnaces at favored localities. And yet, in this connection, there are certain diversities in the cost of pig iron production in different sections of the United States, which may advantageously be studied. Taking four leading centers of production into consideration, the item of fuel shows the following divergencies in relation to the cost of producing pig iron, and to the cost of the ore employed:

Section.	*Cost of fuel in relation to total cost of pig iron.*	*Cost of fuel in relation to cost of ore.*
Alabama	47%	134%
Virginia	39	103
Pittsburgh	18	26
Chicago	34	63

It will be noticed that there is a very wide range in regard to this item. In the Swedish and Norwegian estimates the combined cost of reducing agent, heat and electrodes forms a higher percentage to total cost, than in the average American blast furnace budget.

Still, in such a region as that about Pittsburgh, where relatively ore is high and fuel is cheap, the question may well be raised whether the electric method cannot profitably be introduced for the manufacture of a higher grade of pig iron, utilizing waste gases from the coke ovens in the production of electricity."

"In reviewing the results obtained at Trollhattan, there are several very distinct advantages attendant upon the use of the electric furnace for iron smelting, which may be summarized, as follows, which points are a determining factor, in adopting or rejecting the new method as applicable for any given locality.

1. Very poor grades of ore can be used, such as are totally unavailable for the ordinary blast furnace. This is more particularly the case with ores high in sulphur. Excellent pig iron is yielded by ores containing 1.5% sulphur and even higher amounts. Ores containing over 0.15% sulphur cannot be handled in the blast furnace.

2. Ores in a powdered state can be used. There is no expense of briquetting in such cases, an economy of $0.70 to $1.00 per ton.

3. Coals of all grades can be employed as reducers. There is a much greater freedom of choice than hitherto.

4. Impurities due to fuel are reduced to at least one-third of the present amount.

5. As carbon is required for reducing purposes only, and not for fuel, there is a much greater freedom for the use of charcoal, and for the consequent production of the more valuable charcoal iron.

6. As no blast is employed, and no nitrogen enters the furnace, the formation of nitrides is prevented, and there is a complete freedom from their injurious effects.

7. As phosphorus in the finest grades of charcoal iron is derived exclusively from the charcoal employed, it is possible to reduce this unavoidable impurity to about one-third of the present minimum.

8. Silicon, manganese, and other metals, can be incorporated with great ease in the molten mass.

9. The gases given off are much more valuable and suitable for use under boilers.

10. There is an increased facility for making castings direct, and for the immediate conversion of the molten pig into steel, in an adjacent electric furnace.

11. The composition of the pig is under exceptional control, as the temperature is so easily regulated by altering the tension ratios in the current.

12. Repairs can be more quickly and economically executed than in the ordinary blast furnace, and indications point to a lessened degree of wear, and a consequently longer life.

13. The charcoal pig iron obtained in the electric furnace is admirably adapted for the production of a high grade of Martin steel, for use in tool making, wire drawing, etc.

STEEL WORKS.

The first big steel works in Great Britain to be run solely by electric power is now being erected at Tyenside, after two years of experimental work. Cheap electrical power was a determining factor in its location, according to the U. S. Consular Report of November 20, 1912.

The Girod Furnace for the electric smeelting of steel is now in successful operation on a commercial scale in a number of European Steel Works, according to the Engineering and Mining Journal of December 4, 1909. In a 12 ton furnace at Ugine, old scrap iron is used as raw material for steel making.

Electricity is now being rapidly introduced in steel operations in the United States as its use is much more convenient and economical than other forms of energy.

CHARCOAL.

The charcoal used in connection with the electric smelting of iron ores at Heroult, California, is obtained as a by-product from the wood distillation industry which is run in connection with such iron plant.

It is obtained by running cord wood on cars into a steel cylinder, five feet in diameter and twenty feet long, mounted horizontally on a brick work enclosure, which cylinder is heated to a high temperature using crude oil, after the door has been closed and sealed. The heat drives off all volatile acids and oils, leaving charcoal as a residue. The resulting oils and acids are conveyed through a pipe to a tank and are later refined, producing wood alcohol, acetic acid, wood oil, turpentine, creosote, and finally, acetate of lime. Twenty of these cylinders are to be installed in addition to the present plant at Heroult, California.

WOOD WASTE INCIDENT TO CLEARING LAND.

By promoting the iron industry we may thus indirectly solve the cut-over timber land problem, and the utilization of waste wood products from our saw mills. In every cord of waste wood is said to be about $25 in value.

"From a cord of fir stumps, we get 30 gallons of oils, 60 gallons of acids, and 50 bushels of charcoal", according to Mr. P. J. Zintheao, of Seattle. "It costs about $5 per cord to clear the land and extract the chemicals from the stumps.

The charcoal in the open market brings $5.00 per cord. The oils and acids represent the profits aside from the increased value of the land after it is cleared."

Absolute control of temperature conditions is required for successful wood distillation. The various products are volitalized at different temperatures and much purer products are obtained if the heat can be maintained at a certain temperature for a fixed time, before increasing to that point necessary for the extraction of some other product. It is therefore believed that large quantities of electricity can be used eventually to replace fuel, oil, or coal in the production of heat in wood distillation plants, if power can be obtained at low cost.

"There is no doubt whatever in my mind but that electricity at about $6.00 per horsepower year will replace other methods of heating wood distilling retorts. It has been considered feasible to use electricity at a cost even of $25.00 per horsepower year, says H. K. Benson, of the Department of Chemistry, University of Washington."

"So far as the production of suitable products from wood distillation is concerned, there is no longer any doubt in my mind but that the process is a profitable one. My assurance is based upon our experimental work, as well as upon my factory experience with the plant in your State, located at Linnton. After the completion of the Panama Canal, we shall be in a position to distribute such products over a very much larger area, and the chances then will be even better."

Mr. Benson describes in Volume X, page 544 of the Metallurgical and Chemical Engineer, certain experiments in wood distillation using electric current for heat.

It therefore appears that if the people of Oregon can demonstrate the fact that we have here some of the largest and cheapest water power projects to he had in the world, it is quite probable that Oregon, in the near future will become the center of a vast iron and steel industry. This will create a demand for large quantities of charcoal, which can be obtained as a by-product from wood distillation plants by utilizing waste wood from saw mills and from stumps and other waste in logging operations.

An extensive market for large quantities of cheap electrical power can probably be had in the furnishing of heat for such distillation processes, as owing to the ease with which absolute temperature control can be had with electric current, the wood distillation industry can afford to pay somewhat more for such heat than that obtained from coal or fuel oil.

No difficulty is expected in securing lime or lime stone, necessary for the iron industry, and it is not believed that the obtaining of suitable iron ore is an insurmountable obstacle. Up to this time there has been but little incentive to search for iron deposits, as the price of fuel necessary for successful smelting has been so high as to be a serious handicap to the successful development of the industry.

I am informed by a reliable prospector that a mountain of hematite iron ore, which analyzes 45% iron is located on tide water near Portland, and is within easy reach of both rail and water transportation. It is the opinion of this man that immediately below the hard iron cap on the surface, the deposit will become granular in form and can be loaded by steam shovel directly upon cars.

If this deposit should not materialize, it is quite probable that extensive deposits of iron ore can be found near Cle Elum, Washington, with a down hill rail haul to the power plant. Extensive deposits of iron will no doubt be discovered along the coast, especially in Alaska. The importing of ore from China for smelting in this country is not impractical, if fuel or power can be obtained at correspondingly low prices.

The first step, however, in the encouragement of these industries is to ascertain with certainty the extent and cost of developing water power, so that experts along these various lines of industry may make plans as to what can be accomplished under present and Panama Canal conditions.

FERTILIZER FROM THE AIR.

Perhaps the most extensive use to which our water powers can be put is in the making of fertilizer from the air.

The United States is now sending abroad $32,000,000 annually for the purchase of nitrogen in its various combinations, and over half of this sum is expended for a single item and goes to Chile. (Abstracted from Special Agents Series No. 52, U. S. Department of Commerce and Labor, by T. H. Norton.) An export duty of $11.16 per ton has been imposed by the Chilean Government on saltpeter from which duty about 60% of its revenue is derived. During 31 years, beginning with 1879, the industry and agriculture of the world have paid to Chile, $425,000,000. In no other country have so extensive natural deposits of nitrate fertilizers been found.

Various authorities estimate that natural nitrate deposits of the world will be exhausted somewhere between 1923 and 1955.

The per capita consumption of the entire world for 1910, was 3.34 pounds. In Germany it was 5.18 pounds, and but little over half this amount for the United States. The demand for fertilizer is increasing at the rate of about 10 per cent annually.

Either the wheat producing area must be greatly increased in the near future, or the productive power of the present area increased through the use of fertilizer, if we are to feed the increasing population of the world.

Large quantities of nitrogen are also required in the manufacture of high explosives.

Fortunately, the atmosphere enveloping the globe consists chiefly of nitrogen, being 78 per cent of its volume and 75.5 per cent of its weight. It has been estimated that a column of air resting upon each square yard of the earth's surface contains 5.8 metric tons of nitrogen in the free state, and above one square mile of land is 20,000,000 tons, or sufficient nitrogen to supply the world for the next 50 years at the present rate.

Several commercially successful methods have recently been perfected for extracting nitrogen from the air, and all of which depend upon cheap electrical power, and the presence of an ample and cheap supply of lime or limestone. The latter condition can easily be met, but the first condition of cheap power is the controlling factor.

"The first important commercial production of nitric acid from atmospheric nitrogen was at Niagara Falls, by the Bradley-Lovejoy process. Essentially the process consisted in passing air, or air somewhat enriched with oxygen, through a rapidly alternating high-tension electric spark. Fortunately for the stability of our atmosphere, the "kindling temperature" of nitrogen is very high, else a thunder storm might destroy the world. With the sparks obtained by the Bradley-Lovejoy method, some oxidation of nitrogen was secured, and by absorbing the burned or sparked air in water nitric acid was obtained. The life of the factory was, however, brief. About the same time the Birgeland-Eyde process was developed at Notodden, in Norway, where a much cheaper water power and large supplies of limestone were available. This process differed from that of Bradley and Lovejoy in that the electric spark was spread out by being developed between powerful magnets, thus giving a much larger surface of action upon the current of air which was forced through the spark. The sparked air was then absorbed in water by means of towers similar to the ordinary Gay-Lussac towers of the sulphuric-

acid factory. In this way a low percent nitric acid could be manufactured under exceptionally favorable circumstances. But it was soon found advisable, from a commercial point of view, to absorb this acid in an excess of lime or lime water, thus producing a mixture of lime and lime nitrates and nitrites, of which the principal component seems to be

$$2C_aO\ N_2O_5\ 3\tfrac{1}{2}H_2O$$

a true basic lime nitrate. This substance soon found favor as a nitrogenous fertilizer, especially in northern Germany, and practically all the product of the Notodden factory has gone to that locality for fertilizer purposes, although it is generally understood that it was the intention of the operators in Notodden to develop the method to the point where a concentrated nitric acid could be commercially prepared for the manufacture of high explosives.

Still more recently another method has been developed for the production of nitric acid by the oxidation of nitrogen, this method being controlled by the well-known manufacturers, the Badische Anilinund Soda-Fabrik. In this process a continuous arc is produced in a long tube by first bringing electrodes together and then gradually moving one of them along the tube while the other remains fixed at one end of the tube. The current of air instead of being passed through this arc is passed around it through the tube by being forced in at an angle to the main axis of the tube. It is said that the arcs used in this process vary from 30 to 50 feet or more in length, and are maintained continuously for days or even months at a time. The gases passing from the tube are absorbed in water and give a much higher concentration than those produced by the Birkeland-Eyde process, some of the statements appearing in the current descriptions claiming that an acid as high as 30 per cent is formed.

"Another method for producing nitric acid by the burning of air which has been attracting some attention recently, and which appears to contain great promise, is that known as the Rankin process. The peculiar features claimed for this method are that they use a "fat" spark produced by a current of far lower tension than that employed in the Bradley-Lovejoy or the Birkeland-Eyde processes, and employ electrodes of peculiar construction, the cathode being a hollow iron contrivance through the interior of which is passed continuously a current of cold water, while the anode is a substance of secret composition which is said to ionize the air particles as

they approach the spark. The claim is made for this process that the solution obtained by absorbing the gases in water passed through a specially constructed cooling device is a nitric-acid solution of a considerably higher concentration than that produced by the other processes. It is not possible at present to state how far the Rankin method has become a commercial one, as in many of its details it is what is known as a secret process, and the operations of the company controlling it are not accessible to the public. It can be stated, however, that marketable quantities of high-grade nitric acid have been produced by this process, and that it, like the others described above, is mainly dependent upon the procurement of cheap power.

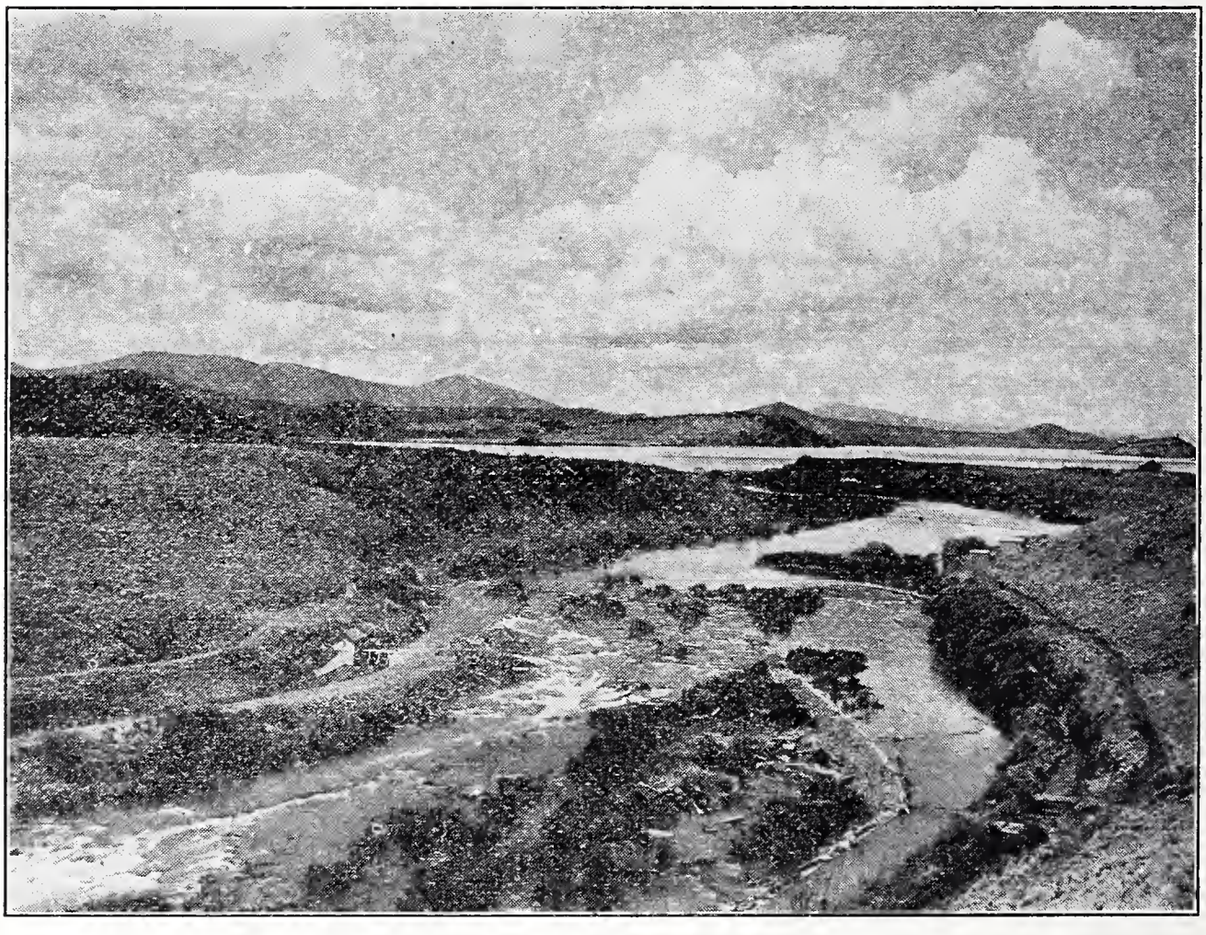
An interesting feature of the work of this company is that they at one time proposed to utilize their acid in the manufacture of superphosphate, which would, of course, contain basic calcium nitrate instead of gypsum.

CYANAMID.

Lime nitrogen or calcium cyanamid utilitizes the atmospheric nitrogen in a manner which, chemically at least, is distinctly different from the processes described above. Calcium carbide is made by heating in an electric furnace a mixture of lime and carbon, or some highly carbonaceous matter, such as coke screenings, tarry, residues, etc. If, now, the process is carried further in an electric furnace of special construction, and a current of nitrogen or air rich in nitrogen is passed over the highly heated carbide, a chemical reaction takes place. If the heat be sufficiently high and prolonged, calcium cyanide is formed, $Ca(CN)_2$ but if a somewhat lower temperature be maintained, the product is mainly calcium cyanamid. CN_2Ca. The calcium cyanide is a valuable starting point for the production of compounds. Calcium cyanamid finds a number of uses in chemical industry; as, for instance, a starting point in the production of guanadin derivatives used in case-hardening steel, etc., but it is mainly used as a fertilizer. It has been claimed as an advantage to the process that Messrs. Frank and Caro, the original inventors, have further devised a scheme for producing nitric acid, starting with cyanamid as the raw product and employing a contact method, but so far the details of the process have not been made public, and it does not as yet seem to have been employed in a commercial way."—(From Bulletin No. 63, U. S. Dept. of Agriculture.)

FUTURE OF THE AIR-NITRATE INDUSTRY.

"It seems certain that the manufacture of nitric acid and the nitrates from the atmosphere is established upon a firm basis and destined to expand steadily within the limitations fixed by the two main controlling factors: First, the cost of the available electrical energy, and second, the market rate, for the time being and certainly for a fair share of the present century, of Chile saltpeter. These may be considered somewhat in detail.



KLAMATH LAKE AND LINK RIVER.

COST OF ELECTRICITY FROM WATER POWER.

"There is great diversity in the cost of water power available for generating electricity. In central Europe, in the Alps, and also in the Pyrenees, there are isolated cases, as noted, where the power is extremely cheap. As a rule with the extension of the use of electricity for illumination, for motive power, in chemical industries and metallurgy, the value of water privileges mounts steadily, and must eventually be measured by the standards fixed for the cost of electricity as produced by steam or gas engines. In certain countries isolated to some

extent from the great industrial movement of the age, such water rights can be secured at present at exceedingly low rates. Western Norway is peculiarly favored in a combination of heavy precipitation, a great number of mountain streams, and marked uniformity of flow during the year. These valuable features gradually diminish on advancing eastward across Sweden and Finland. The cheapest source of energy in Norway is at Odda on the west coast, where it costs $1.96 per horsepower year. The cost advances to $2.94 at Notodden, and ranges up to $12 in eastern Norway. In Sweden there are some instances where power is secured at rates from $6 to $12. In most cases it costs over $12. In the United States the range is from $2.50 at Sault Ste. Marie to $12—$20 at Niagara Falls. There are possibilities in Alaska where heavy precipitation is combined with great elevation. There would appear to be great possibilities on the Zambezi, and along the slopes of the mountain regions of equatorial Africa, as well as on the eastern slopes of the Andes. It is the peculiarity of the air-nitrate industry, employing water, air, and limestone almost exclusively as raw materials, that it can be located in the most inhospitable regions, provided that ample water is available and that transportation to the seaboard is not costly.

COST OF ELECTRICITY DERIVED FROM COAL.

"The engineers in charge of the Notodden and Saaheim works informed me that they confidently expected a gradual increase in the efficiency of the furnaces. With some increase it may be possible at an early date to use coal as a source of energy for the production of nitric acid at least, and possibly for nitrates. By using blast furnace gas of about 900 calories in the largest type of gas engine it is possible to generate cheaper than by any other means than water power. The kilowatt hour costs in this case 0.357 cent, or $23 per horsepower year. In the large house at Louisenthal there are three steam turbines, each of 3,000 kilowatts. The cost there is 0.714 cent per kilowatt hour, or $46 per horsepower year. Were it possible to locate this power house at a coal mine, so as to avoid transportation expenses, the cost would be brought down to 0.476 cent, or $30.70 per horsepower year. *Ordinary steam engines are able to generate electricity under favorable conditions at $61 per horsepower year.* It must not be forgotten that with each year there are improvements in the transformation of heat into electrical energy. In the Berlin Electrical Works, four years ago, it was possible to secure 111 kilowatt hours from 1,000 calories. In 1911 the yield was 128

kilowatt hours. While such progress is being made with the use of steam as a source of power, it is probable that the highest economy can be attained by the aid of powerful gas engines.

"It is hence quite probable that at no distant date the air-nitrate industry may not be exclusively dependent on cheap water power as a source of electrical energy.

INFLUENCE OF CHILE SALTPETER ON PRICES.

"According to the data concerning cost of production communicated by the Norwegian manufacturers there is a very wide margin at present between the actual cost of nitrogen in the form of Norway saltpeter and the current commercial cost of nitrogen in the form of Chile saltpeter. The natural result will be to multiply factories for producing synthetic nitric acid, utilizing more and more expensive sources of electrical energy, until the cost limit is reached at which the products can be profitably marketed.

"Synthetic saltpeter is handicapped to some extent by dependence upon capital. For every $100 of capital invested in Chilean nitrate works there is an annual production of 1.7 tons of sodium nitrate. For the same investment in Norway the annual product at present is 0.32 ton of calcium nitrate, equivalent to 0.27 ton of the sodium salt. This means that the synthetic product requires a capital investment 6.3 times as great as that needed in the exploitation of the Chilean deposits. The capital now invested in Chilean works is $136,000,000. It would require a capital investment of about $860,000,000 to assure the production of an amount of Norway saltpeter equal to that now consumed by the civilized world, assuming that sufficient cheap water power were available.

"If no artificial restrictions are placed upon the output of Chilean saltpeter, a period may eventually be reached when competition will bring about a rapid lowering of the price. The Chilean industry is able to accommodate itself to a certain range of fluctuations, as shown by the average prices per ton of saltpeter in European ports during the past 30 years: 1881-1885, $53.28; 1886-1890, $43.05; 1891-1895, $40.82; 1896-1900, $35.72; 1901-1905, $44.58; 1906-1910, $47.63.

"Very sharp competition would lead steadily to a closing of the less profitable nitrate works in Chile, on the one hand; on the other hand, establishments producing nitrate with high-priced electricity may find it impossible to struggle against falling rates. The battle will finally be between *the cost of electricity in various parts of the world* and the cost of fuel,

as well as the cost of labor, in Chile. This last factor, the cost of labor, is more elastic than the other two.

"There are, however, other determining moments that will effect the problem in varying degrees. The world's demand for combined nitrogen may increase more rapidly than at present, and it may be difficult to meet. The date for the beginning of the exhaustion of the Chilean nitrate fields may arrive more quickly than is now expected.

"Synthetic ammonia may assume great industrial importance. The production of ammonia from coal or peat may be developed at a rapid rate, the price of the by-product being exceedingly elastic, and free to a considerable extent from restrictions by ordinary competitive laws.

"Atmospheric nitrogen may be secured economically in other forms than ammonia or nitric acid. The manufacture in the form of cyanamid may assume large proportions. The transformation of atmospheric nitrogen into a combined form in connection with certain forms of plant life, as a result of bacterial agency in the soil, may play a large role in agriculture and affect the demand for fertilizers.

"Finally, the mechanical and chemical methods for converting atmospheric nitrogen into nitric acid and the nitrates may be more highly perfected, so that the normal yield may be notably increased. For the time being this field of invention is attracting the chief attention of European chemists and engineers, and their work may be briefly reviewed."

PRICES AND PRODUCTION.

"For many years the price of Norway saltpeter must be controlled by that of Chile saltpeter, at least as long as the manufacture is dependent on extremely cheap water power. There will, therefore, be no material cheapening of the price for the benefit of agriculture under the present conditions. In fact, all the water power of Europe would not suffice to produce one-half of the nitrate now required in the world's markets.

With the present output the manufacture is limited to such regions as Norway, where power on a large scale can be secured for $3 per horsepower year. Prof. Flusin, of Grenoble, calculated that with the rates for water power now prevailing in France 1 kilo of combined nitrogen would cost 34 to 49 cents.

"The actual production of nitrate in Norway shows the rapid growth of the new industry. In 1905 the export of calcium nitrate was 115 tons; in 1907, 1,344 tons; in 1910, 13,531 tons. The export of sodium nitrate rose from 900

tons in 1908 to 3,200 tons in 1910. In the latter year 1,074 tons of sodium nitrate were exported. It is estimated that about 2,000 tons of calcium nitrate are used annually as fertilizer in Norway. Including a certain amount of nitric acid for local consumption, the total production for 1910 was equivalent to about 22,000 tons of calcium nitrate.

"Of the exports of calcium nitrate in 1910 the bulk went to three countries, viz., Great Britain, 5,100 tons; Germany, 4,791 tons; Netherlands, 1,687 tons; other countries, 1,953 tons. Nearly the entire export of sodium nitrate went to Germany. When the water power at Saaheim is completely utilized for the production of nitrate, the total Norwegian output will reach about 160,000 tons. This is equivalent in nitrogen to 5.7 per cent of the world's production of Chile saltpeter in 1910. As has been stated, the manufacture at Notodden is now concentrated very largely on the production of ammonium nitrate. This is much more profitable than using the nitric acid in the production of calcium nitrate."

The two principal artificial fertilizers are Norwegian saltpeter or calcium nitrate, and calcium cyanamide.

COST OF MANUFACTURING CYANAMIDE.

Little is known as to the exact cost of producing cyanamide. Pitaval stated, in 1909, that the French factory was able to manufacture it at a cost of $32.22 per short ton. The product was then selling for $40.27 per short ton. Under the present conditions at Odda, carbide being figured at $9 per short ton and nitrogen by the Linde process at $3, the following is the estimated cost of 20 per cent cyanamide per short ton under the most favorable conditions: 400 pounds of nitrogen, $0.60; 1,800 pounds calcium carbide, $15.20; labor, $3.00; electric current, $1.00; general expenses, $2.20; total, $22.00.

"This represents a cost of 5.5 cents per pound of nitrogen in the combined form, and is a little over one-third of the current cost of Chile saltpeter or ammonium sulphate. The margin is large, with the prospect of still greater economy in the future. It is evident that more expensive sources of electric power can be utilized in the manufacture than the waterfalls of Scandinavia or the Alps without bringing the total cost up to that of the standard forms of combined nitrogen.

CONSUMPTION OF ELECTRIC CURRENT.

"Frank and Caro have established the fact that the cyanamide process, as at present perfected, does not require more

than *three electric horsepower years per metric ton of combined nitrogen (or 2.7 electric horsepower years per short ton), as compared with 11 electric horsepower years in the case of sythentic nitric acid.* This involves the consumption of current in producing carbide and in effecting the absorption of nitrogen. On this basis the cost of manufacturing one short ton of 20 per cent calcium cyanamide may be stated in a general way as follows: 400 pounds of nitrogen, $0.60; 1,500 pounds of lime, $2.00; 1,030 pounds of coke or coal, $4.50; electrode

LOWER DESCHUTES RIVER.

waste, $2.55; labor, $4.10; general expenses, $5.45; total, $19.20. To this is to be added the cost of 0.54 electric horsepower year. The price would range from $2.00 per year, as at Odda, upward. The other items are liable to slight local variations, especially for coal, labor, and general expenses.

"Frank has demonstrated that one electric horsepower, when exerted uninterruptedly and without loss, should yield sufficient carbide to absorb 772 kilos of nitrogen. At present the most efficient carbide works rarely attain more than 60 per cent of the theoretical yield. The future will probably see a higher approximation to the theoretical figure, as well as a more complete absorption of nitrogen in the cyanamide

reaction. It is with this confident expectation that those interested in the new industry face the competition with synthetic nitrates."

I am informed by a representative of the American Cyanamid Company, which is now operating a factory at Niagara Falls, Canada, that if power can be held at a satisfactory price, such company will probably construct a plant in the west, within the next few years. The initial plant would turn out about 25,000 tons of cyanamid per year, and cost $1,000,000. It would occupy 20 acres of land and utilize 13,000 continuous E. H. P. Employment for 200 men would be furnished by such a plant. For raw material 100 tons per day of high grade calcium lime stone and 30 tons per day of coke would be needed. The freight tonnage for such a plant would amount to about 100,000 tons per year, including both in and out bound freight.

GROWTH OF INDUSTRY.

The Norwegian nitrate industry utilized 25 horsepower and four men in 1903 and about 250,000 horsepower and 2,000 men in 1912. Before this industry was established at Telemarken, there were 500 people living in Notodden, against 5,000 in 1912, while Saaheim had only 50 inhabitants, whereas it now has between 5,000 and 6,000 citizens. The largest single power project in the world under one roof, 140,000 horsepower, is located at Rjukan, Norway, and is devoted exclusively to the nitrate industry.

It is said on good authority that this Norwegian company must build an 80,000 horsepower plant each year to keep pace with the demand for their products. California and Hawaii at the present time consume 45,000 tons of Norwegian nitrates annually. As it takes about 1.6 horsepower per year to make one ton of calcium nitrate, it would require a 75,000 horsepower hydro-electric plant on the Pacific Coast to meet the present demand for these products. This is more than the present installed machine capacity of the Portland Railway Light & Power Company in the vicinity of Portland. To secure this industry, we must compete with the world in the matter of supplying cheap electrical power. As long as we retain our special annual water power tax on new developments, it will be useless to attempt to interest capital in the making of fertilizer from Oregon air. The $2 per horsepower year maximum tax is nearly equal to the total cost of development ($3 horsepower year) in Norway. Such industry, if established on the Columbia River in Oregon,

would produce large quantities of rail and water freight, and would assist materially in maintaining regular freight service by water to all parts of the world. It would indirectly be a great benefit to both the agricultural and commercial interests of the State.

CALCIUM CARBIDE.

Another product of the electric furnace is calcium carbide. It is the source of acetylene gas which furnishes a brilliant flame, and when combined with oxygen, produces the highest flame temperature known to science. So powerful is this flame that an eight inch square block of armor plate can be cut in two in a minute. It is also used in various welding processes. Acetylene gas is used in lighting many schools, churches, homes, and other buildings, and very extensively in mining operations.

"According to Conrad, the best works now produce carbide at an expenditure of 4 kilowatt hours per kilo. In one of the best equipped French works, using ovens of 1,000 horsepower, Pitaval in 1908 found the cost of production to be as follows for 1 ton of carbide: Lime, 940 kilos, $2.72; coke, 650 kilos, $6.18; electrode waste, 40 kilos, $3.47; labor, $1.45; repairs, $0.58; electric current, $7.72; general expenses, $3.86; total, $25.98. This is equivalent to $23.57 per short ton. The actual cost at Odda, with its cheap electric power, lime, and carbon, would on this basis scarcely exceed $19 per short ton. The minimum cost in the best works was estimated at $37 per short ton in 1903 and at $92 in 1897. These estimates do not include packing. The sheet-iron cylinders used at Odda for this purpose cost $6 per ton of carbide.

"The average wholesale price of carbide in German works since 1900 has been as follows: 1901, $71.40 per metric ton; 1902, $48.80; 1903, $65.45; 1904, $59.50; 1905, $54.75; 1906, $59.50; 1907, $66.65; 1908, $59.50; 1909, $45.20; 1910, $40.45; 1911, $38.10".

During 1909, in twelve of the leading countries of the world, 382,300 horsepower were devoted to the manufacture of carbide, with a capacity of 359,000 tons annually.

"The introduction of cyanamide manufacture has been welcomed by all interested financially in the carbide industry as offering the prospect of a much larger field for the use of the material than is afforded by the current demand for acetylene for purposes of illumination or for autogenetic welding.

"Despite the fact that the existing carbide factories are not working as a rule to their full capacity, new works are

constructed each year. Among the latest projects are large plants in Mexico and in the Transvaal to meet local requirements and avoid the heavy freight charges upon the present supply. Numerous owners of coal mines in Silesia have recently combined to construct a large carbide factory in competition with the European syndicate which has its headquarters at Paris".

ELECTROLYTIC ALKALI.

The manufacture of alkali, or the carbonate and hydrate of sodium, from common salt by the electrolitic process is a growing industry requiring large quantities of cheap electric power.

The Castner Electrolytic Alkali Company of Niagara Falls, wrote, under date of October 22, 1912, that "we have been considering the advisability of putting up an alkali plant, operating under our process, on the Pacific Coast, and your price for power is attractive. We shall require for our business, pure salt, coal, and quicklime".

According to the Encyclopedia Britannica, by far the simplest process for making alkalis, together with free clorine, is the electrolysis of sodium (or potassium) cloride.

"It stands to reason that the electrolytic processes have been principally developed in localities where the electric curcent can be produced in the cheapest possible manner by means of water power, but this is not the only condition to be considered, as the question of freight to a center of consumption and other circumstances may also play an important part".

ALUMINUM.

Cheap electrical power must be had for the successful production of aluminum. Cryolite, which is found only on the west coast of Greenland, was for a time the principal source of the metal, but owing to its inaccessibility, has been abandoned in favor of bauxite, which is more widely distributed. It is found in Syria, Austria, Hesse, French Guinea, India and Italy, the most important beds being located in the south of France, the north of Ireland, and Alabama, Georgia, and Arkansas, in North America. The ore from these states is shipped to Niagara Falls where cheap electrical power in large quantities can be had. With the Panama Canal completed, this industry could be established along the Columbia River in Oregon, at least to the extent necessary to supply the market bordering the Pacific Ocean, and if electric power could

be had at low enough cost, pehaps it may be found practicable to ship the finished product to the eastern states.

The uses of aluminum are too numerous to mention. Perhaps the widest field is still in the purification of iron and steel. It is rapidly replacing brass and copper in all departments of industry. With the increased price of copper, it is coming into vogue as an electrical conductor for uncovered mains. When the price of aluminum is less than double the price of copper, aluminum is cheaper than copper per unit of electric current conveyed; but when insulation is necessary the smaller size of copper wire renders it more economical.

The aluminum industry at Niagara Falls has had a rapid growth, employing at the present time over one thousand men. The plant covers a larger area than any other plant on the Niagara frontier.

I am informed by a representative of the Aluminum Company of America, that such company would be interested in establishing a plant in the west to consume 40,000 to 50,000 horsepower, if a power lease for 30 to 40 years could be had at a very low price, and that such works would in from five to seven years, require 100,000 to 150,000 horsepower, or more. This company employs between 200 and 250 men for each 10,000 horsepower. At this rate the company, after seven years would employ over 3,000 men. Figuring each employee to represent 3½ people, such factory would add 10,000 to the population of the State.

CARBORUNDUM.

Carborundum is used extensively as an abrasive. Over 12,000 horsepower is now used at Niagara Falls in the production of a million pounds of carborundum per month. It is made in the electric furnace from bauxite, the mineral of the metal aluminum. Carborundum resembles much in looks and hardness, the black diamond, and for polishing stones has taken the place of diamond dust which was worth about $1,000 per pound. Its principal use in the making of emery wheels which are now replacing the old fashioned grind or sandstone, and the iron and steel business has been very greatly benefited by this discovery. It is one of the best abrasives known.

GRAPHITE.

Acheson-graphite is an artificial graphite manufactured in the electric furnace from anthracite coal and petroleum coke, and requires a temperature of 7,500 degrees Farenheit. Its

chief use is in the manufacture of electrodes, lead pencils, and as a powder for dry batteries, paint pigment and lubricants.

By the process of defloculation, Acheson-graphite is made so fine as to be in a molecular condition. It is said that the Interborough Rapid Transit Company which operates the New York subway, has reduced its oil bill at least 60% through its use with a material saving in power formerly wasted in overcoming friction.

It is said on good authority, that the Acheson-Graphite Company, at Niagara Falls, has 22 furnaces, 11 being in operation continuously and using on the average about 5,000 Kw. This company employs about one man to each 3 E. H. P. consumed. They pay for delivered power approximately $15 per horsepower year, which is thought to be about the prevailing price paid by the aluminum, alkali, and other industries located at this point.

GOLD.

The electric furnace at Luvia de Ore, cyamid mill, Chihulua, Mexico, is probably the first one to be used for melting precipitate or smelting gold-silver concentrate, according to the Engineering and Mining Journal of July 15, 1912. Bullion is the only product shipped. The melting capacity is 400 Kg. of precipitate in 24 hours.

ELECTRO CHEMISTRY.

The employment of cheap electrical power in the electro chemical industries is growing rapidly in the United States. We are no longer entirely dependent upon imported chemicals from Germany. Such chemicals as chlorate of potash, caustic potash, bicarbonate of soda, muriatic acid, liquid chlorine, carbon tetrachloride, tin tetrachloride, bleaching powder, phosphorous, caustic alkali, metallic sodium and cyanamid, are now manufactured either in whole or in part through electrolytic processes. What the future of electro-chemistry is, no one can foretell. Its horizon is widening every day with new discoveries.

Mr. C. W. Marsh, of Niagara Falls, writes that " we will be interested in a location on the Pacific Coast provided the supply of raw material and the market is such as to enable us to compete with the eastern situation. We are manufacturing caustic soda, and bleach. Our chief consumers are soap factories, textile works, and book and paper manufacturers. The raw material we require is salt at a cost of $2.50 per ton or less, high calcium lime at $5.50 or less, and power at $15 per E. H. P. or less.

The Hooker Electrochemical Company writes that it "will be interested a little later in the location of a chemical plant on the Pacific Coast, provided we can secure cheap power, salt, limestone, and fuel, with proper freight rates to the markets of the Pacific Coast. By next spring we will be consuming 10,000 horsepower per year in the making of caustic soda and bleaching powder."

HEAT, LIGHT AND POWER.

Electricity for heat, light, and power, is now being used almost exclusively in many industries. At Bogalusa, La., a saw mill cuting 175,000,000 feet of lumber per annum is entirely operated by electricity. Its use in railway shops, in breweries, grain elevators, shoe factories, woolen mills, pulp and paper mills, and factories of every description is gradually becoming more general. All bake ovens in the immense shredded wheat biscuit plant at Niagara Falls are heated by electricity. In silk mills and factories requiring small quantities of steam for special purposes, small boilers are heated directly by electricity.

It is said that the Hotel Stanley, at Estes Park, Colorado, having its own electric plant, uses electricity for almost every conceivable purpose around the building as follows:

ELECTRICAL COOKING AND HEATING EQUIPMENT, HOTEL STANLEY, ESTES PARK, COLORADO.

Apparatus.	*Maximum Watts.*
Bake oven	10,500
Roasting ovens (2) each	3,600
Broiler 28 x 30 inches	7,200
12 slice toaster	7,800
Roll warmer	600
Serving table	5,500
Plate warmer	4,800
20 gal. stock and vegetable kettles (3)	5,000
1 12-gal. water	3,600
Battery of urns, 2 6-gal. coffee, each	1,000
3 bucket egg boiler	800
4 disc range	4,800
1 gal. cereal cooker	1,000
2 gal. cereal cooker	2,000
12 x 18 inch griddles (2), each	2,100
Water heater for kitchen supply	20,000
Water heater for bath and wash rooms	20,000
Steam boiler for laundry	85,000

The following figures relate to a new process for the electric heating of oils, potash, parafine, water, etc.

The apparatus is made in units of from 1,000 to 40 gallons capacity, weight ranging from 2,500 to 300 pounds. They are made of boiler plate, etc., and one or more rows of dead end tubes are expended into the sides just above the base.

Each unit of the heating system is so arranged that in case of accident it is instantly blown out and thus disconnected from the series without interfering with the continued heating of the other units. The kilowatt consumption of the heaters ranges from 79½ kilowatt for the 1,000 gallon unit, to 16½ for the 40 gallon unit, and the time required to heat from 50° to 212° Fahrenheit, ranges from 6.7 hours to 1.3 hours for the smallest. Cost of the heaters ranges from $660 to $200, and with the controlling panel from $41 to $18. A discount of 10% is allowed to central stations and supply dealers. Figures are taken from the records of the General Electric Company.

The city of Rupert, on the Minidoka project in Idaho claims the unique distinction of having more houses, both business and residence, heated by electricity than any other city in the United States. Electric ranges for the kitchen are also being installed in many homes. All of this has been made possible by reason of the fact that the electricity as a by-product of the government irrigation works, is supplied at a very low rate to the consumer. This power was developed incidental to the pumping project and would otherwise be wasted. Consequently a low rate is made in order to compete with coal in the heating of houses. (Reclamation Rec. Dec. 1912). The distribution of electricity in small quantities for heat, light, and power is relatively more expensive than its production and sale in large quantities. As retail rates bear but little relation to wholesale rates, owing to the various commercial factors involved, and the whole matter is rather technical and complicated, no attempt will be made in this report to compare relative prices.

PRESENT POLICY.

The various uses for cheap electrical power described above are only a few of the uses which have come to the writer's attention. Much additional information can be found in the 1913 report of the Oregon Conservation Commission, relative to both power and irrigation development.

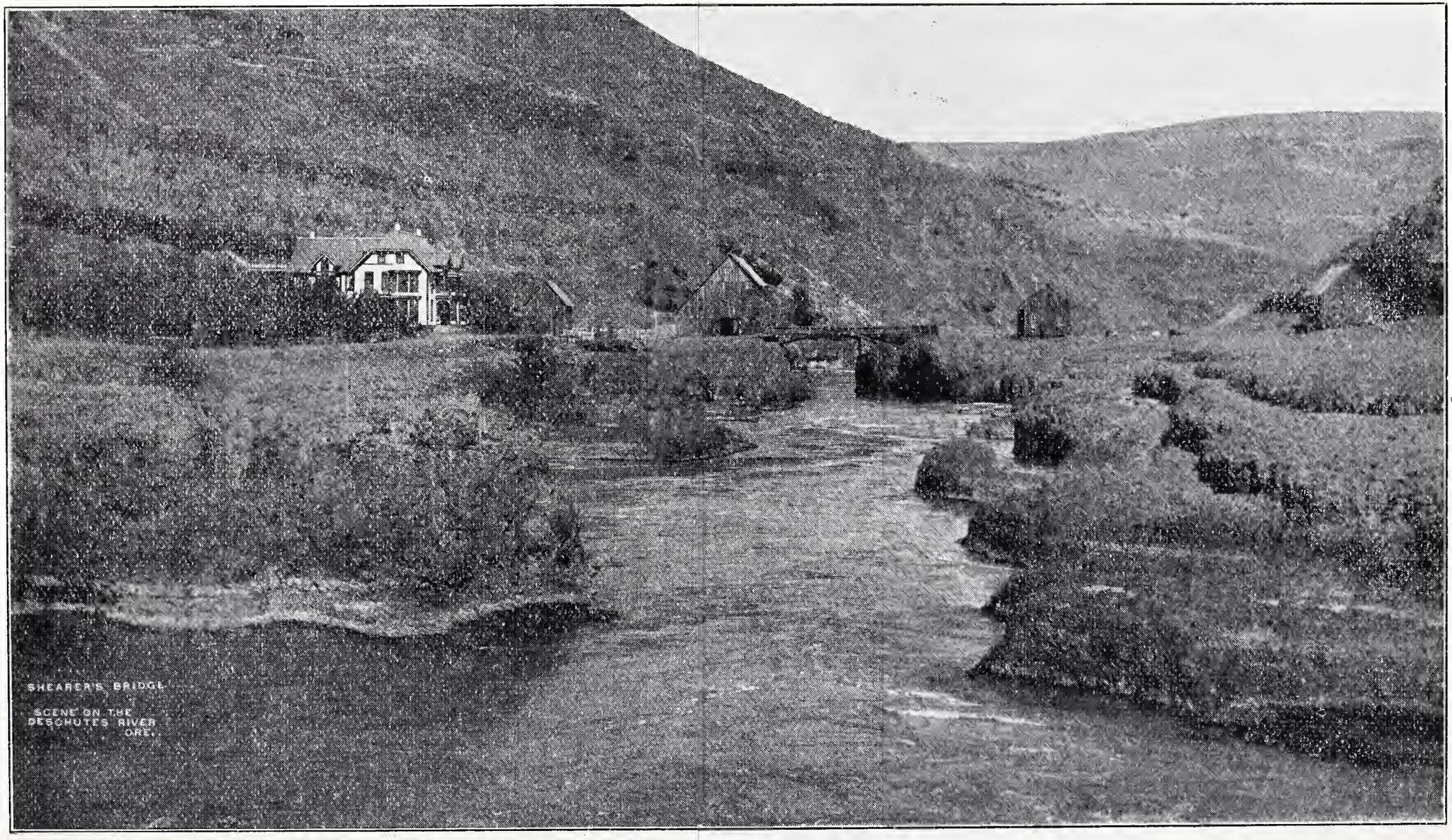
Owing to the very rapid development which has taken place in the field of electricity within the past few years, it is apparent that the ideas based upon uses and prices of six years ago, may not be applicable at this time.

Irrigation.—The Carey Act and the National Reclamation Act, apply only to vacant public lands. As but few projects remain where any considerable portion of the land is in public ownership, we can expect but little from these acts in the future. The security for private capital invested in Carey Act projects is not the best, as many things are liable to happen before the lien attaches, and such lien may then be worthless if sufficient additional money cannot be secured to complete the project. There are many objections to the irrigation district law, the principal one from the standpoint of development being the difficulty in selling the bonds where the land is arid and perhaps not worth, in its natural state, one-fourth the amount to be borrowed. What is wanted is some new policy applicable to reclamation and settlement of private lands of little value for dry farming purposes.

Power.—The State of Oregon has no well defined policy relating to the development of her water powers, notwithstanding the fact that this State is perhaps the only one in the Union which limits franchises to the use of water for power purposes, and imposes an annual tax upon each horsepower developed. These restrictions were adopted in 1909 without any special thought or information and imposed only upon new developments. In 1911, a small annual license fee was imposed upon existing power plants primarily for the purpose of securing information as to the extent of vested rights, the revenue to be used in gathering information necessary to promote new developments.

The tax law limited franchises to the use of water for power purposes to a period of forty years from the date of initiation of the right and required the payment of an annual tax, to be adjusted from time to time by the State Water Board, depending upon the percentage of power appropriated, which is put to beneficial use. This tax shall be fixed at not less than 25 cents, nor more than two dollars per horsepower per annum, depending upon the percentage of power appropriated, which is put to use. So far, only the minimum fee has been imposed, which, with an assumed plant efficiency of 50 per cent, makes the tax only 12½ cents per theoretical horsepower appropriated.

The license fee is imposed only upon those plants which used water prior to 1909, under the theory that State regulation of streams is necessary for an orderly development of the industry. This fee is graduated, being ten cents for each theoretical horsepower claimed, up to and including 100, five cents from 100 to 1000 and one cent for each horsepower in excess of 1000. The revenue for 1912 amounted to $3,550.86,



POWER POSSIBILITIES ON THE DESCHUTES RIVER.

and was expended largely on water power surveys and investigations, in cooperation with the U. S. Geological Survey, which organization contributed $3,000 for similar work in Oregon. This law is defective in that it does not reach those power rights which were initiated prior to 1909, but where no water was put to beneficial use until after such date. This is the class of claims of which a record was most desired. It was anticipated that a small annual fee would discourage many speculators, thus clearing the field for legitimate development. The tax law mentioned above was based upon the theory of revenue for the State Treasury, while the license law was based upon the theory of development through the collection of information to encourage the industry. These two policies are directly antagonistic.

Several of our leading political organizations have recently endorsed the policy of *development* as opposed to *revenue*, as it is believed that the indirect benefits derived through the taxation of new wealth, through added fields of employment for labor and through the comfort and convenience of our citizens which will come with reduced electric rates, will far exceed any possible direct benefits. To carry out the development policy and compel the application of excessive profits, to the reduction of electric rates, it is proposed that the State construct enough plants to regulate the market and insure cheap prices.

We have in the streams of Oregon something over 3,300,000 horsepower, which is now running to waste. To produce this power in steam engines would consume 36,000,000 tons of coal annually which at $4.00 would be worth $144,000,000. We are beginning to appreciate the fact that this power is of no value unless put to use, that there is only a very limited market at prevailing commercial prices, that the higher the tax, the less power will be used; and the lower the tax, the greater the use, provided prices are based upon cost of production rather than upon the principle of all the traffic will bear.

The perfection within the past few years of the electric furnace and the invention of many new electrochemical and other methods whereby large quantities of cheap electrical power can be used, has made necessary the adoption of some policy which will permit such industries to be established in Oregon. A $2.00 tax imposed upon an industry which can only afford to pay from $4 to $8 per horsepower year would be a very considerable item, and no doubt would compel such industry to locate in some other state or territory, whereas, such $2.00 tax would hardly be noticeable where commercial

rates are charges of from 1⅛ to 7 cents per kilowatt hour (or $74 to $460) per horsepower year. Our old ideas based upon retail prices should give way to some policy harmonizing with wholesale prices, as it is only by encouraging these new industries to locate in Oregon, that we can ever hope to utilize any considerable portion of our undeveloped water power. The revenue policy may be of benefit to existing plants, as successful competition by new plants will be impossible to the extent of the tax imposed. It also may be of benefit to adjoining states, imposing no such restrictions as the tendency will be to construct water power projects just over the line where they are free from such restrictions and transmit power for sale in Oregon. If the revenue policy is adopted by either State or Nation, it appears advisable that the revenue be expended within the State, in the extension of electric service to those sections not so favorably located, so that all may enjoy equal benefits from this natural resource.

A summary of the water permits issued by the State Engineer during the past two biennial periods, ending November 30, 1912, is believed to be significant of the depressing influence of the revenue policy upon water power development. The second period shows a 90 to 100 per cent increase over the preceding period in the number of permits issued, miles of canals to be constructed, number of acres to be irrigated, the only projects failing to keep pace with this increase being those for power development which show a relative falling off for the second period.

Due to these various complications, the retarding influence of the revenue policy upon development and to the growing feeling that the anticipated revenue will not be as great as was expected, sentiment now appears to be swinging strongly to the policy of development and use. A well organized effort is now being made to interest adjoining states and the United States to cooperate with Oregon in the construction of those large irrigation and power projects, which are beyond the reach of private capital.

GRANGE RESOLUTIONS.

The following resolutions were adopted at the annual convention of the Oregon State Grange at Roseburg, May 17, 1912:

"*Whereas*, The State of Oregon is blessed with almost unlimited water power resources which are now largely undeveloped and going to waste, and

"*Whereas*, This power, if developed and put to use on the farm, in our factories and cities at reasonable rates, would

tend greatly to stimulate the development of Oregon, and promote the comfort and prosperity of the present generation without jeopardizing the rights of posterity, and

"*Whereas,* It has *not* been the policy of existing hydro-electric power companies to build transmission lines into new territory, and supply electricity at such rates as will tend to encourage development and settlement, and it appearing necessary that some of the luxuries of life which have come to be considered necessities, be supplied to the farmer at prices within his reach, in order to check the present unhealthy trend of country folks city-ward, therefore

"*Be It Resolved,* That it is the sense of the Oregon State Grange, that any legislation proposed for the solution of the water power problem be based *not* upon the principle of deriving a large revenue for the State or the Federal treasury, but rather upon the idea of supplying electricity at the lowest possible cost, thus conserving our coal, our oil, and our timber supplies, and promoting the rapid development of our State, and

"*Be It Further Resolved,* That the Oregon State Grange does hereby endorse the general policy of cooperaton between the State and Nation in the control and development of water power sites, and in the distribution and sale at cost, of electric power so generated, and that a committee of three be appointed by the Worthy Master and instructed to use every legitimate means to further legislation to such end and to cooperate with any other like committees or agencies working along similar lines."

FEDERAL POWER POLICY.

We have been laboring under the mistaken notion that the State controls the water within its borders.

For all practical purposes, the United States controls both land and water upon the "public lands, forests and other reservations" within the Western States for irrigation, power, and other beneficial uses.

The "regulations concerning rights of way through the public lands and reservations of the United States" issued by the Department of the Interior, August 24, 1912, and the Regulations concerning Water Power in "The Use Book" of the Forest Service, could be no more complete respecting the use of water for power purposes had the United States full control, and the states no control whatever over water. While these regulations deal only with water power, there appears to be no reason why these departments could not, under the same law,

issue other regulations imposing an annual charge and limiting franchises for the use of water for irrigation, domestic, and other purposes, where any part of a reservoir, ditch, canal, or pipe line necessary for such use, was located upon Government reserves.

The permits for water power development, when issued, bind the permitee to construct the works in accordance with approved plans, to begin and complete construction within a fixed time, to operate the works and to pay annually in advance, a graduated rental charge per horsepower per annum ranging from ten cents to one dollar. For good cause a lower rental may be fixed. These permits are revocable at will by the Secretary, but terminate in fifty years unless renewed by application made not less than two years prior to such date of expiration. These restrictions are very much the same as those imposed by the State under water permits except for the revocable character of the Federal permits. The regulations, however, require the applicant for right of way to comply with the State laws relating to water which adds further complications, as the State franchise limitation is 40 years and different dates are prescribed for the various steps to be taken in perfecting the water rights than those prescribed for perfecting the land right.

These regulations are issued under the Act of February 15, 1901 (c 372 31 Stat. 790) entitled "An Act relating to rights of way through certain parks, reservations, and other public lands." For years, it was assumed that such rights of way were to be granted free to encourage development in the West, except perhaps for the payment for timber or other Federal property destroyed. Recently, under the new policy of obtaining revenue from the remaining timber, coal, and other resources upon the public domain, this old act has been construed to authorize the administrative departments to issue regulations imposing annual charges and other restrictions on the use of land recently withdrawn for power development.

If the State also adopts the revenue policy, there is danger that the combined charges will be so high as to make development impracticable in competition with fuel power. Under such policy, electric rates in the Western States will be higher than in the Eastern States, because of the increased price of coal used in competing plants, and those states having abundant water power resources will be deprived of any special benefits therefrom, such as accrues to the Eastern States through the presence of cheap coal.

It is quite probable that these Federal regulations will be upheld by the courts as being within the law. It is a generally accepted proposition of law that the State cannot pass any act authorizing the condemnation of rights of way over Government reservations, or enact any other law inconsistent with the Federal law or rulings thereunder.

Owing to the divided control which has existed between the State and the Nation in the matter of streams, and to the very uncertain and chaotic condition of present water laws, it is quite probable that Congress will not take definite action on the water power question for many years. Inasmuch as a large percentage of undeveloped power within the State is now controlled by the United States, through land reservations, it appears impossible to adopt any comprehensive State policy which will ignore the rights of the United States. To secure immediate development, it appears therefore that the most likely policy will be for the State to cooperate with the United States in working out some definite policy acceptable to both.

CONCLUSION.

Because of the great importance to the future development and prosperity of our State, it is important that the 1913 legislature take some action looking toward the solution of the water power and irrigation problem.

Heretofore we have talked in general terms of our great and valuable water resources. We have provided only for general investigations. It is now high time that we get down to something tangible and definite. What we need is detailed information on one or more large irrigation and power projects so that we can ascertain definitely the benefits which will accrue from their development.

Having such information, we can then figure out some plan to secure such development if it is found to be desirable.

If the U. S. Reclamation Service cannot cooperate, spending dollar for dollar in the investigation of a power project, the State should undertake such work alone, as a water power policy must be decided upon in the near future.

If $144,000,000 worth of coal were being wasted annually in central Oregon because private capital refused to build a railroad to carry it to market, the State would not be slow in devising some means of preventing this enormous waste.

We have in Oregon, its equivalent in "white coal" which is going to waste annually for want of private capital to furnish the necessary harness and distribute the power to those who

can use it. Instead of encouraging private capital we have imposed penalties in the way of special taxes and restrictions not found in other states. These may, in the end, prove beneficial but the State must furnish the money to investigate and show how these resources can be developed and put to use with profit to the capital employed. The greater the restrictions, the less will private capital be interested, and the more we must do ourselves.

A general plan has been outlined above, whereby it is believed that this definite information can be secured without ultimate expense to the tax payer. If private capital cannot be interested in carrying out such plans, the public having the information, will be in a position to adopt some new policy which will accomplish the desired end.

TOPOGRAPHIC SURVEYS.

The United States Geological Survey is engaged in making a topographic map of the United States, and has been constantly engaged in this work since 1879, when this Bureau was created. Up to the present time, only about one-third of the United States has been mapped and a great deal of the money expended in this work has been appropriated by the various states in order to facilitate the work. In 1905, the State of Oregon appropriated $2500 with which to cooperate with the United States Government in this work; in 1911, an appropriation of $20,000 was made to be expended on topographic and hydrographic surveys in the State. During 1911, $17,000 and during 1912, $15,000 was expended on topographic surveys.

The total area of the State of Oregon is 96,699 square miles and there has been mapped to date, 20,581 square miles, or about 21%. Should work progress at the rate of the past two years, it is estimated that it will take about thirty-eight years to complete the map of the State, and about four years to complete the Willamette Valley Survey. While the conditions of the State will probably not justify an increase in the present appropriation, it is hoped that at some future time, the appropriation will be increased as to materially lessen the time required for the completion of the topographic map of Oregon. It must be remembered that for every dollar appropriated by the State, two dollars are expended within its borders. The total area which has been surveyed and mapped within the State is shown by the sheded area in figure 7. The heavy diagonal lines indicate the areas over which preliminary triangulation has been extended and which must be

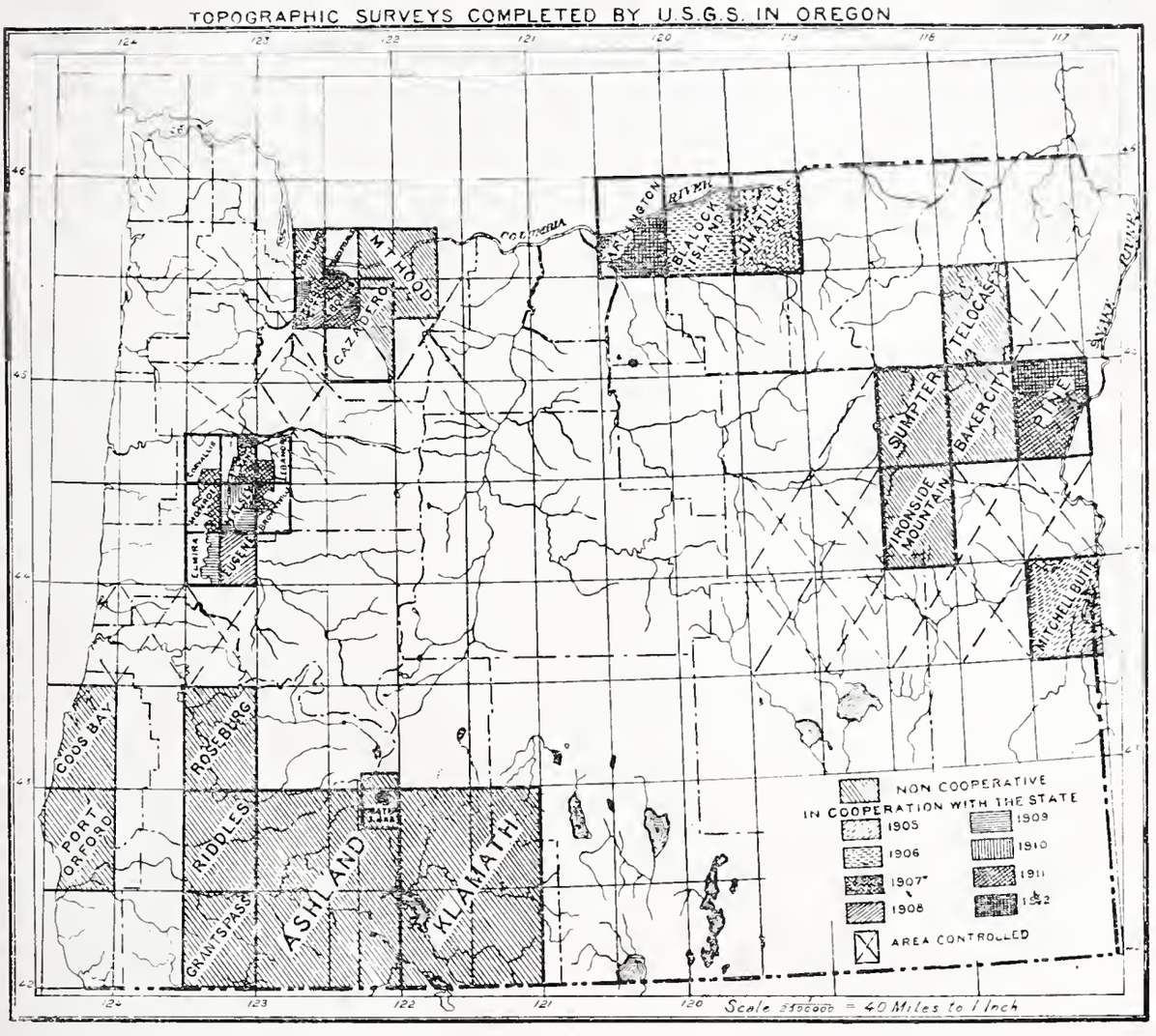


FIG. 7.—SHOWING PROGRESS OF TOPOGRAPHIC SURVEYS.

done prior to the beginning of topographic survey. Each quadrangle has printed within its border, a name by which the finished map is designated.

The surface geology, underground streams, and mineral deposits have been worked out for the Port Orford, Coos Bay, and Roseburg quadrangles, and published in folios bearing such names.

The maps show the topographic features of the land, such as mountains, hills, valleys, and gulches; all bodies of water such as lakes, marshes, streams, and springs; the routes of travel, such as railroads, wagon roads, and trails; political boundaries; cities, towns, and permanent buildings; and the names of natural and other features. They also include exactly the location of permanent survey monuments and bench marks whose positions and whose elevations above sea level have been determined by precise methods—monuments that are available as starting points for local surveys. The maps of areas covered by public land surveys show all town-

ship and section lines, as well as the boundaries of all land grants.

To illustrate the manner in which contours express the three conditions of relief (elevation, horizontal form and degree of slope) Figure 8 is presented, The sketch represents a

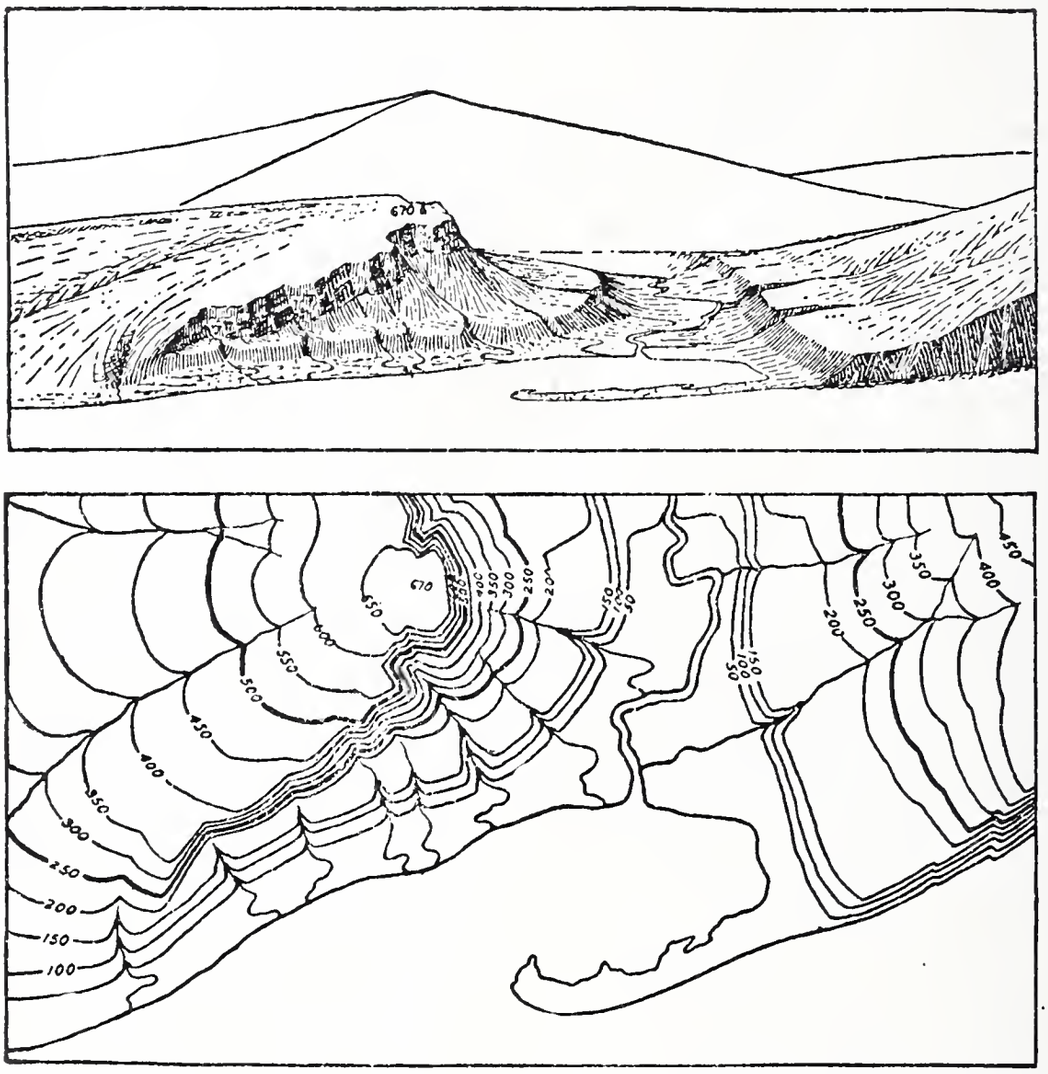


FIG. 8.—The upper figure represents a sketch of a river valley, with terraces, and of a high hill encircled by a cliff. These appear in the map beneath, the slopes and forms of surface being shown by contours.

valley between two hills. In the foreground is the sea, which is partly closed by a hooked sand bar. In the map each feature of the sketch is shown directly below by means of contours. The slope of the ground is represented by the nearness of the contours and the elevation of each is written on the map.

The value of topographic maps in the future development of Oregon can hardly be overestimated. Through our extensive advertising, we are endeavoring to induce capital to invest money in the development of our natural resources, but this cannot be accomplished by the presentation of generalities alone. Some definite information must be available in order

that capital, seeking investment, may have some objective point and will not be required to scour the State seeking the most advantageous location.

In the development of hydro-electric power, topographic maps play an important part and in fact are essential to such development and if not made at the expense of the State, capital seeking such investments is likely to go to those states where such information is available. These maps show the natural conditions of the country in which such development is made, and coupled with definite hydrographic data, giving the flow in the stream from which the power is to be developed, the maximum power development can be readily ascertained.

The maps are even more extensively used in determining the feasibility and extent of irrigation projects, as they show the acreage and general characteristics of the land which can be irrigated from any proposed point of diversion from the stream and in fact serve as a preliminary survey for any proposed irrigation project, permitting the party proposing the reclamation of the land to begin the preparation of final surveys, plans and specifications without further preliminary investigation.

We may in general sum up the uses to which these maps are applied as follows: by the Geological Survey as base maps for the sheets of the Geologic Atlas of the United States in surveys made to determine the mineral resources of the county, in the classification of the public lands, and in the study of various geologic problems, many of which have an economic bearing; by the Reclamation Service in irrigation projects in the arid regions; by the Forest Service in the compilation of Forest Atlas folios for use in determining questions of sale, free use of timber, and grazing; in trail construction and other improvements in forest lands; and as a base for field investigations; by the Bureau of Soils in plotting the character and extent of the various soils of the country; and by the Office of Public Roads in determining routes, mileage, location of road-building materials, and topography in country traversed by public highways.

These maps are used by states in State Geological or other surveys, by state agricultural colleges and in good roads investigations; by engineers, for whom the maps serve the general purpose of preliminary surveys for location of railroads, canals, highways, trolley lines, etc.; for providing a water supply for municipal use or for power; in connection with problems involving land drainage or irrigation and they also serve as a means of information for miners in prospecting for and locating mineral deposits; for land investors, through

map representation of local conditions and for travelers or tourists, as guide maps.

Practical working maps are being prepared for the Willamette Valley. They are published on a scale of one-half mile to the inch, and show contours of 5 foot interval, up to 450 feet with 10 foot contours above this elevation. This work is being pushed northward from Eugene and southward from Portland.

In the rolling country adjacent to Portland, these maps will be published on a scale of one inch to the mile and show ten foot contour intervals.

The quadrangle sheet covering South Portland and Oregon City was completed this year and it is expected that the northern portion of this sheet will be finished and available for use by the legislature in ascertaining the desirability of creating a tunnel district looking to the ultimate piercing of the mountain west of Portland, thus opening to development, a large area which is not only nearer to the business center, than much east side property, but avoids the delay incident to the crossing of bridges over the Willamette River.

The cost of topographic maps varies in each case with the character of country, scale, weather conditions encountered. In general, it may be said that topographic maps on a scale of two miles, one mile and one-half mile to the inch, respectively, for conditions in Oregon, will cost $10, $30, and $50 per square mile, or 1.6, 4.7, and 7.8 cents per acre.

Mr. Thomas G. Gerdine, topographer for the U. S. Geological Survey, has directed the field work for both the State and the United States, without compensation from the State. By this plan, duplication and waste is avoided. All topographic work is carried on under a contract which has been executed by the State Engineer of Oregon and George Otis Smith, Director of the U. S. Geological Survey.

A map of any quadrangle, which has been surveyed, can be secured from the Director of the U. S. Geological Survey at Washington, D. C., at a cost of ten cents per sheet or $6.00 per hundred. Folios of Coos Bay, Port Orford, and Roseburg quadrangles can be secured for twenty-five cents each.

The following tabulation gives the results obtained on cooperative work since 1905:

Year	Appropriation		Quadrangle	Area mapped	Cost per square mile
	State	Federal			
1905	$ 2,432 19	$ 3,285 16	Mitchell Butte	729*	$ 7 86
1906	2,500 00	3,380 51	Blalock Island	602*	9 77
1907	2,457 56	4,778 16	Umatilla	724*	9 99
1908	2,500 00	3,757 71	Eugene	215	29 10
1909	2,489 68	5,009 48	Elmira	76	
1909			Halsey	107	
1909			Brownsville	10	
1910	2,492 25	3,670 45	Halsey	107	
1910	1,718 53	4,378 40	Pine	509*	
1910	3,639 49	3,381 33	Oregon City	104	
1911	2,252 26	2,652 92	Boring	202	
1911			Monroe	106	
1911			Corvallis	30	
1911	7,131 74	7,030 01	Albany	76	
1911			Lebanon	54	
1911			Brownsville	24	
1911	520 00		Administrative		
1911	1,737 91	6,231 01	Deschutes River	36	13 36
1911	2,518 57	901 02	Pine	235*	13 36‡
1911	3,316 35	1,675 55	Oregon City	106	59 31‡
1911	1,204 35	896 97	Boring	8	31 68‡
1911			Troutdale	14	
1912	1,668 10	473 79	Arlington	343	8 86‡
1912			Albany		
1912			Monroe		
1912	2,330 86	3,043 32	Corvallis	63	51 21†‡
1912			Lebanon		
1912			Brownsville		

* Only the Oregon portion of this quadrangle is included.

† This represents cost of completed portion of Elmira, Halsey, Monroe, Corvallis, Albany, Lebanon, and Brownsville.

‡ Office work and current expenses will make the probable additional cost per square mile as follows: Pine and Willamette Valley, $1.50; Oregon City, $3.00; Boring, 50 cents; Arlington, $1.00.

STATE EXPENDITURES FOR TOPOGRAPHIC SURVEYS.

DECEMBER 1, 1910, TO DECEMBER 1, 1912.

1910—Balance December 1, 1910, Chapter 71, Laws 1911			$ 39 52
Expended during December, 1910		$ 31 77	
Reverting to State Treasury		7 75	39 52
1911—Allotment for expenditures during year			17,000 00
Expended, Chapter 71, Laws 1911	$ 14,499 98		
Expended, Chapter 228, Laws 1905	2,499 95	16,999 93	
Reverting to State Treasury		07	17,000 00
1912—Allotment for expenditures during year 1912			15,000 00
Expended, Chapter 71, Laws 1911	9,370 13		
Expended, Chapter 228, Laws 1905	1,760 00	11,130 13	
Balance on hand December 1, 1912		3,869 87	15,000 00

HYDROGRAPHIC SURVEYS.

The knowledge as to the amount of water which may reasonably be expected from any given source of supply, is necessary to the maximum development of the water resources of the State. Such information is also necessary to prevent wild cat irrigation and power projects, based upon an appropriation of water from a stream in excess of the amount that can be secured. Every irrigation and power development in

the State is limited by the quantity of water flowing in the stream, from which the water supply is taken. For this reason, an accurate knowledge of the flow of the streams of the State cannot be over estimated.

The systematic measurement of a few of the important streams in the State of Oregon was commenced by the U. S. Geological Survey in 1890. As the funds available for this work were limited, the progress was very slow until 1905, when the Legislature of this State made an appropriation of $2500 to be expended in cooperating with the U. S. Geological Survey in securing data relative to stream flow.

Realizing that the securing of such data was an important factor in the development of the State, the 1911 legislature increased the appropriation so that in that year $7,000 was expended and in 1912, $8650 was expended by the State on such work. All data collected has been published in the Water Supply Papers of the U. S. Geological Survey and are now available to the public, except those few now in the process of publication. However, on many of the important streams in the State, the record is too short to be relied upon for the maximum use of the stream, either for the development of water power or irrigation.

The present cooperative stream gaging work is being carried on under a contract between this office and George Otis Smith, Director of the United States Geological Survey. It provides for the expenditure of equal amounts upon hydrographic surveys within the State up to the limits of the appropriation. The results are to be published annually in the water supply papers of the Geological Survey, without expense to the State.

Mr. Fred F. Henshaw, District Engineer U. S. Geological Survey, Couch Bldg., Portland, Oregon, has direct charge of the details of this work under the above contract. He thus directs the work for both the State and the United States, agreeing with the State Engineer as to the general plan, and serving the State without compensation. By this method, duplication of work is avoided and economy promoted.

The results for the past two years will only be briefly summarized in this report, as the information is published in full at the close of each calendar year by the U. S. Geological Survey in the water supply papers of that department. For each regular station a table is published giving gage heights, a rating table and table of estimated monthly discharge, giving maximum, minimum, and mean discharge in second feet and total in acre feet for each month. This information is given for each of the 194 stations listed below, as well as the result of many miscellaneous gagings at points where no regular stations are maintained.

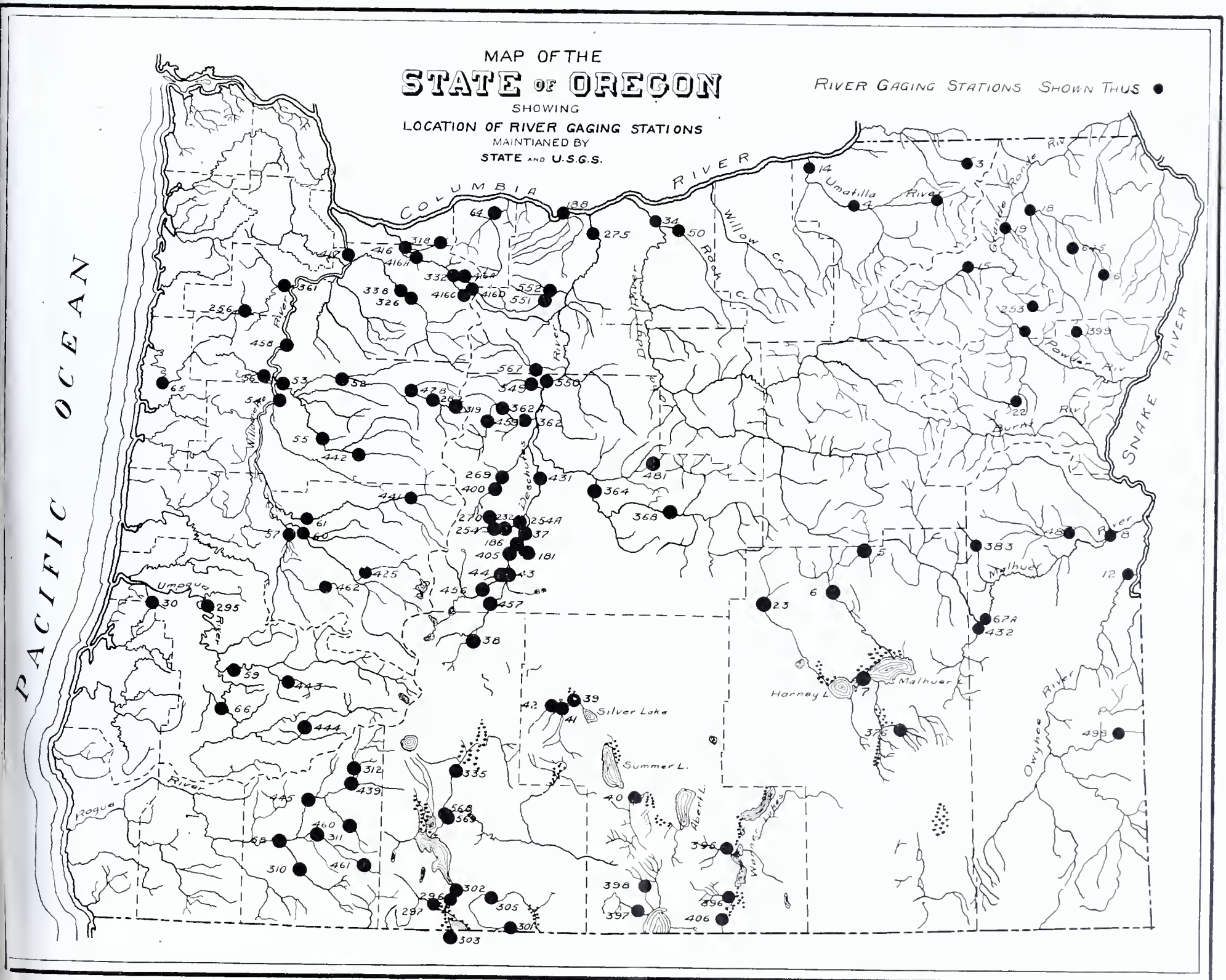


FIG. 9.—SHOWS LOCATION OF GAGING STATIONS MAINTAINED BY THE STATE IN CO-OPERATION WITH THE U. S. GEOLOGICAL SURVEY.

STATIONS IN OPERATION

From December 1, 1910, to November 30, 1912.

No.	Station and locality	Established	Discontinued	Total No. meas.	Extent of readings
1	Umatilla at Gibbon	July 22, 1896	Nov. 20, 1911	1	12 months
3	So. Fk. Walla Walla near Milton	Aug. 10, 1906		3	Complete
4	Umatilla at Yoakum	May 5, 1903		7	Complete
5	Silvies near Silvies	June 16, 1903	June 30, 1911	23	7 months
6	Silvies near Burns	Aug. 14, 1903		28	Complete
7	Lake Malheur at Narrows	1903			Fragm'try
8	Malheur at Vale	May 20, 1903			Complete
12	Owyhee near Owyhee	Aug. 27, 1903			Complete
14	Umatilla near Umatilla	Oct. 21, 1903		5	Complete
15	Grande Ronde at Hilgard	Nov. 6, 1903	Sept. 30, 1911	4	10 months
16	Wallowa near Joseph	12, 1903		2	Complete
18	Wallowa at Minam (Elgin)	18, 1903		3	Complete
19	Grande Ronde at Elgin	20, 1903	Aug. 15, 1912	2	20 months
22	Powder at Salisbury	Dec. 20, 1903		5	Complete
23	Silver Creek near Riley	April 19, 1904		16	Fragm'try
30	Mill Creek near Ash	May 29, 1907	Sept. 30, 1912	3	22 months
34	John Day at McDonald	Dec. 14, 1904		2	Complete
37	Deschutes at Bend	22, 1904		8	Complete
38	East Fk. Deschutes at Crescent	25, 1904		6	Complete
39	Silver Creek at Silver Lake	29, 1904		5	Complete
40	Chewaucan near Paisley	Jan. 4, 1905		9	Complete
41	Bridge Creek at Silver Lake	21, 1905		5	Fragm'try
42	Bear Creek near Silver Lake	21, 1905		4	Fragm'try
43	Deschutes (Little R.) near Lava	Feb. 17, 1905	May 4, 1912	4	17 months
44	West Fork Deschutes near Lava	20, 1905	3, 1912	2	4 months
48	Bully Creek above Vale	1911			
50	Rock Creek at Rock Creek	April 6, 1911	Oct. 21, 1911	3	7 months
52	North Fork Santiam at Mehama	July 11, 1905		3	Complete
53	Santiam at Jefferson	19, 1905		3	Complete
54	Willamette at Albany	21, 1905		2	Complete
55	South Fork Santiam at Waterloo	28, 1905		2	Complete
56	Luckiamute at Suver	Aug. 18, 1905	Oct. 31, 1911		11 months
57	Coast Fk. Willamette near Goshen	23, 1905	Feb. 7, 1912	3	14 months
58	Rogue near Tolo	30, 1905		6	Complete
59	North Fk. Umpqua at Winchester	Sept. 6, 1905		6	Complete
60	Middle Fk. Willamette at Jasper	16, 1905	Feb. 6, 1912	1	14 months
61	McKenzie near Springfield	12, 1905		6	Complete
64	Hood at Winans	Nov. 17, 1905	Feb. 7, 1912		14 months
65	Siletz at Siletz	25, 1905	Aug. 15, 1912		20 months
66	S. Fk. Umpqua near Brockway	Dec. 6, 1905		5	20 months
67[a]	Malheur at Riverside below S. Fk.	15, 1908		4	Complete
181	Central Oregon Canal near Bend	1905		7	Complete
186	Pilot Butte Canal near Bend	1905		2	Complete
188	Columbia at The Dalles	1892			Complete
190	Lake Wallowa near Joseph	1911			11 months
232	Columbia S. Canal near Laidlaw	June 15, 1906		2	Complete
253	Catherine Creek near Union	Aug. 1, 1911		4	16 months
254	Tumalo Creek near Laidlaw	May 15, 1906		3	Complete
254[a]	Tumalo Creek near Bend	Oct. 6, 1906		2	Complete
256	South Fork Yamhill at Sheridan	April 26, 1906	Dec. 31, 1911	1	13 months
269	Squaw Creek at Sisters	June 15, 1906		4	Complete
270	Wimer Canal near Laidlaw	16, 1906		1	Complete
275	Deschutes near Biggs	July 7, 1906			Complete
282	North Fk. Santiam near Hoover (Detroit)	Jan. 24, 1907		7	Complete
295	Umpqua River near Elkton	Oct. 18, 1905		4	Complete
296	Link at Klamath Falls	May 15, 1904		10	Complete
297	Klamath at Keno	Aug. 13, 1904			Complete
300	Miller Cr. near Lorella (Horsefly)	10, 1904		9	Complete
301	Tule Lake near Merrill	May 17, 1904			Complete
302	Upper Klamath Lake nr. Klamath Falls				Complete
303	Lower Klamath Lake near Brownell, Cal.	Aug. 1, 1912			4 months
305	Lost at Olene	May 20, 1907	Mar. 16, 1912	3	15 months
310	Bear Creek near Talent	July 11, 1907		8	17 months
311	Little Butte Creek at Eagle Point	11. 1907		4	Complete
312	North Fork Rogue near Prospect	17, 1907		3	Complete

Stations in Operation—Continued.

318	Bull Run at headworks near Bull Run	Oct. 13, 1907		6	Complete
319[a]	Marion Fork Santiam River at Marion Lake	Aug. 1, 1909		4	Fragm'try
319[b]	North Fork Puzzle Creek	1, 1909		3	Fragm'try
319[c]	South Fork Puzzle Creek	1, 1909		3	Fragm'try
326	Clackamas near Cazadero	Oct. 16, 1907			Fragm'try
332	Sandy at Brightwood (Salmon)	Dec. 12, 1907	Nov. 30, 1911	5	12 months
335	Williamson at Rocky Ford	Mar. 25, 1908		5	7 months
338	Clackamas at Estacada	April 6, 1908	Sept. 13, 1911	1	9 months
361	Yamhill at Lafayette	Oct. 16, 1908		3	Complete
362	Metolius at Rigg's R. nr. Sisters	22, 1908	Oct. 21, 1912	1	23 months
362[a]	Metolius at Hubbard's nr. Sisters	April 24, 1910		3	Complete
364	Crooked near Prineville	Oct. 31, 1908		2	Complete
368	Crooked near Post	Nov. 9, 1908	Aug. 28, 1911	1	10 months
376	McCoy Creek near Diamond	Jan. 27, 1909		22	Complete
382	Powder near North Powder	Mar. 9, 1909	June 30, 1912	1	19 months
383	North Fk. Malheur near Beulah	21, 1909	30, 1912	6	19 months
395	Honey Creek near Plush	May 13, 1909		14	Complete
396	Warner Creek near Adel	11, 1909		19	Complete
397	Drews Creek near Lakeview	Jan. 16, 1909		13	Fragm'try
398	Cottonwood Creek near Lakeview	Nov. 22, 1908		4	Complete
399	Eagle Creek near North Powder	May 20, 1909		1	Fragm'try
400	McAllister's Ditch near Sisters	29, 1909		2	Complete
405	Deschutes at Benham Falls	April 1, 1909		5	Complete
406	Twenty-mile Creek near Warner Lake	Mar. 1, 1910		15	Complete
416	Sandy at Cobb's Camp, near Bull Run	April 27, 1910		9	Complete
416[a]	Sandy at Mt. Hood cable bridge near Sandy	May 8, 1910	Aug. 31, 1912	5	22 months
416[b]	Sandy at McIntyre's bridge near Brightwood	17, 1910		8	Complete
416[c]	Still Creek nr. Government Camp	24, 1910	May 31, 1912	5	18 months
416[d]	Salmon River near Government Camp	24, 1910	31, 1912	5	18 months
417	Willamette at Oregon City	Sept. 4, 1909		7	Complete
425	North Fork of Middle Fork Willamette near Hazeldell	Oct. 12, 1909		2	Fragm'try
431	Deschutes near Cline Falls	Feb. 15, 1910		4	Complete
432	South Fk. Malheur nr. Riverside	May 25, 1910		4	Complete
439	Mill Creek near Prospect	Aug. 28, 1910	Oct. 24, 1911	2	11 months
441	McKenzie at McKenzie bridge	8, 1910		6	Fragm'try
442	South Fk. Santiam nr. Cascadia	3, 1910		6	Fragm'try
443	Little near Peel	Sept. 6, 1910		2	No heights
444	North Fork of South Fork Umpqua near Tiller	9, 1910		2	No heights
445	Rogue at Trail	Aug. 24, 1910		4	Fragm'try
456	West Fk. Deschutes nr. Rosland	Sept. 21, 1910		5	Fragm'try
457	Deschutes near Rosland	22, 1910		4	Fragm'try
458	Willamette at Salem	18, 1910		5	Complete
459	Metolius at Ranger Station near Sisters	16, 1910		3	Complete
460	Big Butte Creek at Butte Falls	20, 1910	Sept. 30, 1911	4	10 months
461	South Fork Little Butte Creek near Lake Creek	22, 1910		7	Complete
462	Row near Disston	27, 1910		3	Fragm'try
478	Breitenbush Creek near Detroit	Oct. 10, 1910		8	Complete
481	Ochoco Creek near Howard	28, 1910	April 2, 1911	2	4 months
486	South Fork Umpqua River near Tiller	Nov. 9, 1910	Dec. 1, 1911	6	12 months
492	North Fork Umpqua River at Hoaglin	2, 1910		4	Fragm'try
498	Jordan Creek at Jordan Valley		Feb. 17, 1911	6	21 months
501	Middle Fork Willamette near Hazeldell	Mar. 22, 1911		3	Fragm'try
508	Trout Creek near Denio	25, 1911	Mar. 31, 1912	9	12 months
509	Little Cottonwood Creek nr. Denio	27, 1911	May, 13, 1912	5	13 months
510	Van Horn Creek near Denio	28, 1911	April 20, 1911	6	1 month
511	Honey Creek at Charlstrand's ranch, Plush	April 7, 1911	Dec. 31, 1911	4	9 months
512	Twelve-Mile Creek near Plush	8, 1911	31, 1911	5	9 months
513	Snyder Creek near Plush	Jan. 1, 1911	31, 1911	2	12 months
521	Deep Creek, Big Valley, nr. Lakeview	May 3, 1911		9	18 months
525	Little Sandy River near Bull Run	21, 1911		9	Fragm'try

Stations in Operation—Continued.

531	Cottonwook Creek at Westfall	Jan. 31, 1911			
532	Cottonwood Creek at Westfall	Dec. 29, 1911			
533	Bully Creek at Westfall	Mar. 14, 1911			
534	Camas Creek near Plush	April 25, 1911		15	17 months
535	Mud Creek near Plush	26, 1911		15	Fragm'try
536[a]	Whitewater Creek near Sisters	May 28, 1911		5	17 months
536[b]	Lake Creek near Sisters	31, 1911		4	17 months
536[c]	Jack Creek near Sisters	30, 1911		1	Fragm'try
536[d]	Canyon Creek near Sisters	30, 1911		1	Fragm'try
537	Cocomongo Creek near Diamond	14, 1911		4	Fragm'try
538	Bridge Creek, P-Ranch, near Diamond	Mar. 18, 1911		12	Fragm'try
539	Krumbo Creek, near Diamond	17, 1911		11	Fragm'try
540	Mud Creek, P-Ranch, nr. Diamond	18, 1911		12	Fragm'try
541	Riddle Creek at Riddle ranch, near Diamond	11, 1911		14	Fragm'try
542[a]	Crump Lake near Adel	May 21, 1910			Fragm'try
542[b]	Hart Lake near Plush	June 8, 1910			Fragm'try
542[c]	Flagstaff Lake near Plush	May 31, 1910			Fragm'try
542[d]	Bluepoint Lake near Plush	31, 1910			Fragm'try
548	Big Applegate River nr. Buncom	June 9, 1911		6	17 months
548[a]	Cameron's ditch near Buncom	July 2, 1911		4	17 months
549	Shitike Creek at Warm Springs	June 11, 1911		8	18 months
550	Deschutes River at Mecca	July 2, 1911		3	17 months
551	White River at Tygh Valley	9, 1911		6	18 months
552	Tygh Creek at Tygh Valley	June 11, 1911	Oct. 15, 1912	6	Fragm'try
557	North Fork Little Butte Creek near Medford	June 23, 1911		5	17 months
562[a]	Lost Creek near McKenzie bridge	July 20, 1911		3	Fragm'try
562[b]	Horse Creek nr. McKenzie bridge	19, 1911		6	Fragm'try
563	Big Fall Creek near Fall Creek	27, 1911	Dec. 30, 1911	2	4 months
565	Middle Fork Santiam at Foster	Aug. 6, 1911	Nov. 13, 1911	2	3 months
566	South Fork Santiam at Foster	6, 1911	12, 1911	2	3 months
567	Warm Springs nr. Warm Springs	July 29, 1911		5	Fragm'try
568	Williamson River at Chiloquin	25, 1911		7	16 months
569	Sprague River at Chiloquin	25, 1911		11	16 months
572	Sandy River at Marmot	Aug. 14, 1911		5	16 months
574	West Fork Eagle Creek nr. Baker	July 25, 1911		1	Fragm'try
575	Cow Creek at Riddle	Aug. 20, 1911	May 18, 1912	3	8 months
578	Eugene Power Canal nr. Walterville	Sept. 7, 1911		3	Fragm'try
579	Wood River near Fort Klamath	Aug. 5, 1911		4	16 months
584	Clackamas River at Park Place	Sept. 15, 1911	April 22, 1912	4	6 months
585	Home Creek near Narrows	May 2, 1911		7	Fragm'try
588[a]	Crescent Lake outlet nr. Crescent	Jan. 11, 1911		5	Fragm'try
588[b]	Odell Lake outlet near Crescent	April 19, 1912		3	Fragm'try
588[c]	Big Marsh outlet near Crescent	1, 1912		3	Fragm'try
589	Four-Mile Creek near Odell	6, 1912		5	Fragm'try
591	McKenzie River at Martin's rapids	Jan. 1, 1911		4	23 months
601	Willamette at Springfield	Nov. 25, 1911		8	12 months
602	Sycan near Yainax	24, 1911		6	Fragm'try
603	Miller Creek, Beaver Marsh, near Fort Klamath	14, 1911		5	Fragm'try
607	Latourelle Creek at Latourelle	Jan. 19, 1912		1	11 months
609	Imnaha River near Imnaha	Dec. 26, 1911		2	Fragm'try
610	Little Sheep Creek near Joseph	21, 1911		2	Fragm'try
612	Dog Creek near Lakeview	Jan. 17, 1912		3	Fragm'try
613	Thomas Creek near Lakeview	1, 1912		7	Fragm'try
616	Deschutes at Sherar	Feb. 13, 1912			10 months
617	Ochoco Creek at Prineville	Mar. 11, 1912			Fragm'try
624	North Fork Little Butte nr. Lake Creek	25, 1912		3	Fragm'try
625	Crooked Creek at Valley Falls	April 2, 1912		2	8 months
626	Lost, Wilson's bridge nr. Klamath	Mar. 14, 1912		10	8 months
627	Silver Creek near Riley	12, 1912		1	Fragm'try
629	Sprague near Yainax	April 19, 1912		4	Fragm'try
632	Fall River near Lapine	July 19, 1912		1	Fragm'try
641	North Fork Umatilla nr. Gibbon	17, 1912		2	5 months
640	Minam River at Minam	June 19, 1912		2	5 months
645	South Fork Wallowa nr. Lostine	Aug. 27, 1912		1	3 months
646	Deschutes River near Crescent	31, 1912		1	3 months
652	Calapooyia Creek nr. Suthealin	Sept. 17, 1912			Fragm'try
653	Luce Land and Dev. Co. Canal at Sutherlin	17, 1912		3	Fragm'try
659	Salmon River near Brightwood	30, 1912			2 months
660	Chewaucan at damsite nr. Paisley	June 25, 1912		3	5 months

The location of the foregoing stations is shown graphically in Figure 9. According to the report of the District Engineer, U. S. Geological Survey, the average number of stations maintained from December 1, 1910, to December 1, 1912, is 140, the average cost per station for two years is $244.00, or $122 per station per year. Total discharge measurements secured, December 1, 1910, to December 1, 1912, 868, average cost per discharge measurement, $40.00.

The following is a statement of the money expended on hydrographic surveys in this State for the period beginning December 1, 1910, and ending December 1, 1912:

STATE EXPENDITURES FOR HYDROGRAPHIC SURVEYS.

DECEMBER 1, 1910, TO DECEMBER 1, 1912.

1910—Balance December 1, 1910, Chapter 71, Laws 1911			$ 223.60
Expended during December, 1910		222.53	
Reverting to State Treasury		1.07	223.60
1911—Allotment for expenditure during the year			$7,000.00
Expended under Chapter 71, Laws 1911	$4,499.60		
Expended under Chapter 228, Laws 1905	2,499.70	$6,999.30	7,000.00
Reverting to State Treasury		.70	
			$8,650.00
Expended under Chapter 71, Laws 1911	$6,273.61		
Expended under Chapter 228, Laws 1905	1,758.06	$8,031.67	
Balance unexpended December 1, 1912		618.33	8,650.00

STATEMENT OF EXPENDITURES OF THE GOVERNMENT FUND ON HYDROGRAPHIC SURVEYS.

DECEMBER 1, 1910, TO DECEMBER 1, 1912.

Dec. 1, 1910, to Dec. 1, 1911—	
U. S. Geological Survey, district charges	$4,315.20
U. S. Geological Survey, Washington office computations	729.15
U. S. Reclamation Service	61.00
U. S. Geological Survey, publishing data	1,881.63
U. S. Indian Service	228.55
U. S. Forest Service (partly estimated)	1,824.00
Total Federal Funds	$9,039.53
Dec. 1, 1911, to Dec. 1, 1912—	
U. S. Geological Survey, district charges	$4,016.32
U. S. Geological Survey, Washington office computations	1,604.15
U. S. Geological Survey, publishing data	2,108.88
U. S. Reclamation Service	141.95
U. S. Indian Service	1,548.15
U. S. Forest Service	824.05
Total Federal Funds	$10,243.50
Total expenditures of State Funds on Hydrographic Surveys for the biennial period	$15,253.50
Total expenditures of Federal Funds on Hydrographic Surveys for the biennial period	$19,283.03

It will be seen from the foregoing that every dollar appropriated by the State for hydrographic surveys secures to the State for expenditure within its borders, of more than $2.00,

and while no increase in the appropriation for this work is recommended at this time, yet, it is believed that much more money could be expended on this work, to the great advantage of the State.

CHEMICAL SURVEYS.

The quality and chemical composition of the water of a stream may affect its availability for use as a domestic supply, for boilers, manufacturing and other industries and for irrigation. In order to determine the fitness of the State's waters for these various uses, a chemical survey was undertaken by the Geological Survey. Daily samples have been collected at 24 points on 21 rivers in the State for a year, and analyzed in groups of 10 days.

In all 842 separate water analyses have been made in the laboratory at Salem. Of these 808 were for river waters and involved the search in each case for nine or more minerals in solution, in addition to the determination of color, turbidity and total solids.

A report embodying the results of the study will be available early in 1913. The chemical surveys have been carried on by Mr. Walton Van Winkle, who has had direct charge of the work for both the State and the United States, and without salary from the State. This work was carried out in accordance with a contract between the State engineer and George Otis Smith, Director of the U. S. Geological Survey.

EXPENDITURES ON CHEMICAL SURVEYS, 1911 TO 1912.

From State co-operative fund, 1911	$1,000.00
From State cooperative fund, to December 1, 1912	1,232.60
Total	$2,232.60
From Federal Fund, 1911	$1,645.61
From Federal Fund to December 1, 1912	736.53
Total	$2,232.60

SUMMARY OF WATER PERMITS ISSUED.

Since the issuance of the last biennial report, 1570 applications for permit to appropriate water have been filed with the State Engineer, covering uses for irrigation, power, mining, manufacturing, domestic, stock raising, generation of steam, storage, etc., and ranging in extent from the irrigation of a small garden tract to projects involving the reclamation of thousands of acres, and from the generation of one, to 20,000 horsepower. About 15% of all such applications are ultimately cancelled or allowed to lapse, owing to failure to complete the required surveys, financial difficulties, or the

speculative nature of the enterprise. The failure of the majority of large power projects initiated may be due partially to the fact that they are speculative in nature, and partly owing to the heavy annual fees imposed by law.

During the two year period just past, 1144 applications have been found to be in proper form, approved, and issued as permits, which, together with the 602 permits issued during the years 1909 and 1910, raises the total issued under the present water code, to 1746.

These permits authorize the construction of 3,667 miles of main canal to supply water for the irrigation of 973,546 acres of land; and the development of 176,978 horsepower. The storage of 2,110,484 acre feet is contemplated, which will submerge 76,589 acres. The cost of the works described in these permits approximates $44,360,000.

The great majority of these 1746 permits are for original or new diversions, only 156 being for the enlargement of existing works, and 213 for the storage of water in reservoirs during flood season.

The following is a summary of information relative to original enlargement and reservoir permits, issued since the enactment of the water code:

	Biennial periods		Per cent increase
	1st period	2d period	
ORIGINAL PERMITS			
Number issued	467	910	95
Miles of ditch to be constructed under such permits	872	1,983	127
Number of acres to be reclaimed	238,493	581,739	144
Number of horsepower to be developed	60,621	98,557	62
Total estimated cost of construction	$ 8,658,795	$19,735,887	130
ENLARGEMENT PERMITS			
Number issued	71	85	20
Miles of ditch to be constructed under such permits	438	374	—15
Number of acres to be reclaimed	82,209	71,199	—13
Number of horsepower to be developed	12,132	5,668	—53
Total estimated cost of construction	$ 1,259,345	$ 1,089,816	—13
RESEVOIR PERMITS			
Number issued	64	149	133
Total capacity in acre feet	657,867	1,452,617	120
Total number of acres to be submerged	30,184	46,405	53
Total estimated cost of construction	$ 5,706,174	$ 7,916,408	38

TOTALS FOR ALL THREE ABOVE CLASSES

	Total	1st period	2d period	Per cent increase
Number issued	1,746	602	1,144	90
Total miles of ditch to be constructed	3,667	1,310	2,357	80
Total number of acres to be reclaimed	973,640	320,702	652,938	106
Total horsepower to be developed	176,978	72,753	104,225	43
Total estimated cost of works	$ 44,366,425	$ 15,624,314	$ 28,742,111	70

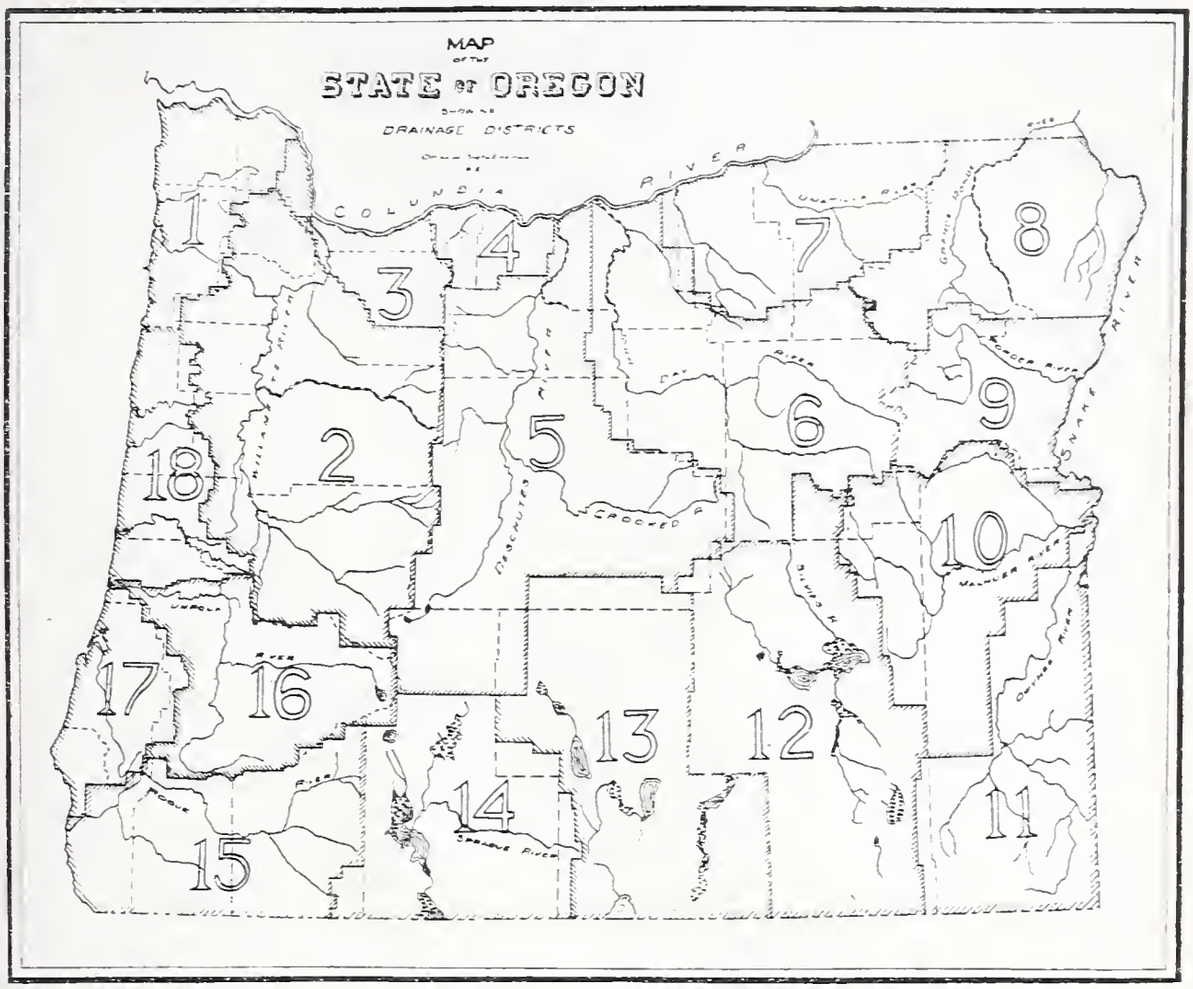


FIG. 10—DRAINAGE DISTRICTS FOR CLASSIFYING PERMITS ISSUED

The remarkable increase in the number of permits issued during the last biennial period and the extent and cost of the works involved, is ample evidence of the confidence of the water users of the State in the new system of water titles.

The two year period just past, shows a 90% to 100% increase over the preceding period, in miles of ditch constructed, cost of works, and area of land to be irrigated, the only projects failing to keep pace with this increase being those for power development, which show a relative falling off for the second period. The fact that the appropriations for power development have not increased as rapidly as those for other purposes is believed to be significant of the depressing influence of the law imposing high annual fees, upon water power development.

The foregoing statistics are believed to be a fairly reliable index as to the development of the State's water resources, as during the 1909, 1910, 1911, and to October 1, 1912, a total of $47,592.00 was collected prior to the issuance of such permits and paid to the State Treasurer. This amount is $7,592.00 in excess of the appropriation for the expenses of

the State Engineer's department for four full years. The permit holders at least have confidence in their own projects to the extent of the fees paid.

The following table will show the distribution of permits as issued by this office during this biennial period, arranged by drainage basins, and numbered to correspond with the number of such drainage basin as shown in Figure 10.

SUMMARY OF INFORMATION CONCERNING PERMITS ISSUED DEC. 1, 1910, TO DEC. 1, 1912

FOR DIRECT DIVERSIONS	Length in miles		Cost in dollars		Area—acres		Horsepower	
	1st period	2d period	1st period	2d period	1st period	2d period	1st period	2d period
1	27.288	44.62	$ 217,800	$ 268,700	438.3	21,087	318	1,387.00
2	58.997	162.63	151,930	4,150,965	4,930.7	3,456.17	253.5	63,796.3
3	15.874	12.43	139,638	2,035,625	14	288.02	791	860.33
4	45.315	18.46	96,185	27,850	4,813.5	9,561.50	2,554	180.00
5	62.25	221.98	143,600	973,680	8,199	66,412.63	11,005	689.60
6	75.634	121.03	249,705	77,803	5,990.15	29,323.19	906	5,103.10
7	70.81	102.01	2,985,745	496,937	61,793.2	9,571.18	369	1,557.50
8	59.196	58.83	388,300	314,185	1,303.4	22,677.75	625	5,529.00
9	98.33	268.56	1,048,804	2,636,276	36,321.1	81,164.39	1,000	1,255.00
10	63.598	191.53	10,225	2,122,035	3,165.8	107,725.93	5,099	463.00
11	20.792	73.84	13,605	894,400	1,453.8	47,654.06		
12	50.965	65.72	19,375	185,510	8,987.19	12,809.00	2,600	80.00
13	10.75	33.60	160,800	28,575	4,476.9	6,289.80	2,525	56.00
14	20.51	102.12	555,045	1,154,175	17,726	39,031.56	25,424	100.00
15	108.43	369.24	1,216,406	2,745,650	20,215.05	118,596.26	7,002	3,550
16	53.265	40.88	1,087,107	338,936	58,441	6,023.00	120	1,423.80
17	25.459	72.81	143,900	1,257,600	118	58.00		12,500.00
18	51.38	12.03	30,625	26,985	106	10.00	30	27.10
	872.601	1,972.32	$ 8,658,795	$ 19,735,887	238,493.09	581,739.45	60,621.5	98,557.73
FOR ENLARGEMENT OF EXISTING WORKS								
1		.33	$	$ 500		20		2.78
2	7.75	3.40	23,500	4,000	965.6	20,227	600	
3	189.899		17,250		12		787	
4	4.00	2.35	300	1,500	408	180		
5	64.575	148.12	28,495	69,220	6,434	6,790.8		7
6	22.155	69.13	7,000	411,400	2,169.9	27,954.67		14
7	9.59	6.25	10,000	200	769	113	200	
8	5.40	3.04	1,750	3,800	505.15	312.50	85	
9	52.46	79.3	31,100	43,810	6,809	8,141.35		
10		16.33		28,500		2,553		
11	5.25		2,500		160			
12	15.905	4.18	2,600	700	707	200		
13	2.6		800		300	360		
14		11.79		400		570		
15	57.16	8.00	1,120,050	511,500	62,879.5	459.5	10,460	5,645
16	1.50	20.87	4,000	14,286	90	3,238		
17			10,000					
	438.244	373.09	$ 1,259,345	$ 1,089,816	82,209.15	71,119.82	12,132	5,668.78

FOR RESERVOIR PERMITS

	Capacity—acres—feet		Area—acres		Cost in dollars	
	1st period	2d period	1st period	2d period	1st period	2d period
*						
1	143.20	163.00	8.43	10.40	$ 15,000	$ 20,000
2	11,388.00	11,310.80	609.10	500.92	50,000	70,100
3	56,260.00	24,000.00	1,134.00	2,355.00	937,365	321,000
4		1,483.20		62.93		5,042
5	2,035.00	151,471.50	187.96	6,001.31	5,050	399,740
6	37.04	43,072 00	4,762.00	967.88	102,500	607,630
7	189,000.00	1.15	7,652.00	.23	1,549,000	50
8	32,175.00	43,300.00	840.79	780.00	238,238	272,842
9	22,421.70	280,827.10	3,582.74	5,034.22	853,777	2,376,358
10	183,302.78	480,904.20	3,719.55	12,864.30	1,467,900	1,572,720
11	2,012.00	121,035.00	320.93	2,734.00	3,250	753,666
12	4,622.00	46,656.50	579.98	2,260.45	33,000	196,310
13	17,812.22	27,347.30	757.05	3,857.33	17,300	53,110
14	21,005.00	104,620.00	3,391.80	4,784.20	20,000	481,100
15	115,625.99	1,507.13	2,633.17	493.02	413,394	178,450
16		49,742.00		2,224.40		368,290
17	27.00	42,700.00	4.10	1,315.00	400	225,000
18		160.00		160.00		15,000
	657,866.94	1,430,300.88	30,183.60	46,405.59	$ 5,706,174	$ 7,916,408

* Drainage district for summarizing information see Fig. 10 for boundary lines.

CONDENSED SUMMARY

FIRST BIENNIAL PERIOD, FEBRUARY 24, 1909, TO DECEMBER 1, 1910

	Miles of ditch	Estimnted cost	No. of acres	Horse-power
Number direct permits, 467	872.60	$ 8,658,795	238,493	60,621
Number enlargement permits, 71	438.24	1,259,345	82,209	12,132
Number reservoir permits, 64	*657,867	5,706,174		†30,184

* Capacity—acre-feet. † Area in acres.

CONDENSED SUMMARY

SECOND BIENNIAL PERIOD, DECEMBER 1, 1910, TO DECEMBER 1, 1912

	Miles of ditch	Estimated cost	No. of acres	Horse-power
Number direct permits, 1,377	1,972.32	19,735,887	581,739.42	98,557
Number enlargement permits, 156	373.09	1,089,816	71,199.82	5,668
Number reservoir permits, 213	*1,430,400	7,916,408		†46,405

* Capacity—acre-feet. † Area in acres.

FEES COLLECTED AND PAID TO THE STATE TREASURER.

Year	1st Quar.	2nd Quar.	3rd Quar.	4th Quar.	Total
1905	.....	65.00	26.05	25.75	116.80
1906	95.00	90.00	85.00	77.00	347.00
1907	160.80	76.75	91.00	103.00	431.55
1908	174.75	202.75	255.80	315.50	948.80
1909	412.00	887.59	2,308.28	2,435.89	6,143.76
1910	1,736.25	4,466.12	5,014.92	2,582.19	13,799.48
1911	4,239.75	3,657.31	3,915.54	3,414.36	15,226.96
1912	3,564.45	5,547.71	3,309.50	.....	12,421.66
Totals	10,383.00	14,993.23	15,006.09	9,053.69	49,436.01

It will be observed from the foregoing table that there has been a gradual increase in fees each year. During the past four years, the increase has been quite marked, and the total for this period exceeds by $7,591.86 the total appropriation for the expenses of the department of State Engineer.

WORK OF THE BOARD OF CONTROL.

Summary of Adjudications.

As the work of the Board of Control overlaps from year to year, and some determinations cover a period of several years, it is difficult to state definitely the amount of work accomplished during a stated interval. Since the issuance of the last biennial report, decrees have been handed down by the Board of Control establishing all water rights on Willow Creek in Malheur County, Cottonwood Creek, North Powder River, Butter Creek, Sucker Creek, and Althouse Creek. None of these decrees have, as yet, been confirmed by the Circuit Courts.

Proceedings to determine water rights on Rogue, Umatilla, Crooked, Powder, and Silvies Rivers are nearing completion, and testimony will be taken as to the rights of the various claimants to the waters of Lost River, Cherry Creek, and Chewaucan River, during the month of December, 1912.

Ninety-nine petitions have been filed with the Board of Control, asking for the determination of old water rights, but surveys looking to this end have been undertaken on only twenty-one different stream systems. Complete adjudications have so far been made by the Board on fifteen different stream systems, involving a total of 1068 separate rights. These determinations affect title to water for the irrigation of 106,686 acres of land, at a total cost to the claimants of $11,175.

Nine of these determinations have been confirmed by the Circuit Court in the respective counties, and 496 final water

right certificates issued, covering 19,845 acres of land, the average cost in fees to these certificate holders being $10.50.

October 1st of this year, marked the expiration of the time allowed by the Board in the Squaw Creek decree for the completion of inchoate rights granted therein. A resurvey of the entire district was made by a representative of the Board to ascertain the extent to which old rights had been perfected, and a supplementary decree will be entered in the near future, in accordance with such investigation. Final certificates will eventually be issued to the various claimants.

The following tabulation shows the adjudications which have been completed to date by the Board of Control, the first nine of which have been confirmed by the courts:

Stream	County	No of rights involv'd	Irrigation		Fees paid	Average cost per right
			Vested acres	Inchoate acres		
Willow Creek	Gilliam and Morrow	204	5,936	355	$ 2,056	$ 12 60
Mill Creek	Union	115	2,035		659	7 85
Squaw Creek	Crook	110	7,072	9,408	1,085	13 56
Tumalo Creek	Crook	149	3,058	25,120	865	7 84
Paulina Creek	Crook	23	530	174	193	11 33
Cochran Creek	Grant	8	35		25	5 03
East Branch Mud Creek	Umatilla	19	532		156	9 15
South Branch Mud Creek	Umatilla	19	445		114	7 60
Goodman Spring Branch	Umatilla	11	202		59	9 79
North Powder River	Baker	134	20,496	499	2,244	16 74
Butter Creek	Umatilla and Morrow	62	7,712		1,062	17 13
Cottonwood Creek	Malheur	4	173		58	14 61
Sucker Creek	Josephine	87	2,162	2,391	428	4 92
Althouse Creek	Josephine	20	749		126	6 31
Willow Creek	Malheur	103	25,842	1,760	2,056	19 96
Totals		1,068	76,979	39,707	$11,175	

The magnitude of the work involved in one of these adjudications and the lack of sufficient funds to employ additional assistance is responsible for the seeming slowness of the Board, and the length of time required to complete investigations and render a decree. For instance, the Rogue River adjudication involves the examination of 315 different streams which are tributary to the main Rogue River, directly or indirectly, and 843 ditches diverting water therefrom. The rights of 1,126 claimants must be settled, covering the irrigation of 36,427 acres, and the proposed irrigation of 132,740 acres; also the development of 74,429 horsepower. In addition to this stupendous task, the Superintendent must hear several hundred contests, which necessitates the calling of witnesses, the taking of testimony, as in ordinary court proceedings. It can be readily understood, therefore, why it is impossible to grant petitions for adjudicating streams as soon as they are received, and why the Board is several years behind in its work, at the present time.

The filing and indexing, and tabulation of these rights, and correspondence with the numerous claimants involves an enormous amount of clerical work which requires experienced office assistants. It is the plan of the present secretary of the Board to index every paper filed with the Board so that it may be referred to at a moment's notice. Water rights are indexed by stream, township, and name of claimant, so that complete information can be furnished parties interested in a particular tract of land, a certain stream, etc.

Annual proof as to the prosecution of work under permits issued by the State Engineer, is required by the Board, which proofs when received are recorded and filed with other papers relating to the particular permit which they cover. Thus it is possible to ascertain at a single glance, the status of any particular permit right. It is the plan of the Board, if sufficient funds are available during the year 1913, to make a field inspection of each such right, upon which final proof has been received, prior to the issuance of final water right certificate. Over one thousand such inspections should be made during the coming year.

ANNUAL POWER FEES COLLECTED BY BOARD OF CONTROL.

Under Chapter 236, Laws of 1911, p. 418.

Section 6576, Lord's Oregon Laws, requires that the Board of Control collect certain annual fees for water power development, under appropriations initiated since May 22, 1909, and states that such rate may be fixed by the Board at from 25c to $2.00, depending upon the amount of power appropriated which is put to beneficial use.

The attorney general has ruled that no fees can be collected under this law except in cases where the appropriation has been completed, and the water applied to beneficial use. Accordingly, the Board of Control, at a meeting on January 22, 1912, entered the following order:

> 'Now at this time, it appearing to this Board that there has been no money provided whereby the Board can make inspections to ascertain the amount of theoretical horsepower applied to beneficial use, under Section 6576, Lord's Oregon Laws;
>
> "It is hereby *Ordered* that the Board shall proceed upon the assumption that the general plant efficiency is fifty per cent (that is, that one-half of the theoretical horsepower appropriated is actually applied to some beneficial use); and the Board hereby fixes the annual fees for such power in each case at 12½c per theoretical horsepower, as mentioned in the permit issued by the State Engineer."

The number of power projects initiated since May, 1909, which are completed and in operation, is of course, small, and includes only the smaller plants. Hence the amount of fees collected to date under this law totals only $406.10.

Out of a total of 141 power projects initiated since May, 1909, representing the development of 202,386 theoretical horsepower, only 17 plants have been completed up to the present time, involving the development of 4964 horsepower. Three projects for the development of 433 horsepower have been abandoned and several others are doubtful.

According to the time limitations placed upon the permits by the State Engineer, governing the prosecution of work, the construction of 42 projects must be completed during the year 1913, involving the development of about 15,600 horsepower. Projects have also been initiated for which construction work will not be completed until 1914, for the development of 32,389 horsepower. The records show that in 1915, plants having a total capacity of 32,378 theoretical horsepower will be completed; while 1916 will witness the completion of plants for the generation of 39,962 horsepower. Permits have been issued for the construction of four large projects, involving the development of 77,000 horsepower, which will probably not be completed until 1917.

ANNUAL LICENSE FEES.

Chapter 236, Laws of 1911, provides for the payment of an annual license fee to the State, by all appropriators of water for power purposes who developed power prior to the enactment of the present water code, which went into effect February 24, 1909. Such fee is payable on or before the first day of January of each year (in advance), the penalty for delinquency being a 25% increase in the amount of fees due. Appropriators are also required to submit with these fees, a written statement showing the extent and nature of their claim. The rate per horsepower is fixed at 10c up to and including 100; 5c for each horsepower up to and including 1,000; and 1c for each horsepower in excess of 1,000. Projects undertaken by the State, the United States, and municipal corporations, also plants for the development of 25 horsepower, or less, are exempt from the payment of fees, but are required to file the statement.

Sixty-nine statements were filed during the year 1912, accompanied by fees in the sum of $3,550.86. These statements represent claims to sufficient water which under the fall as given in each case, will aggregate 228,000 theoretical

horsepower, and range in amount from claims for about twenty horsepower, to plants like that of the Portland Railway Light & Power Company, claiming 136,363 horsepower, for which fees were due in the sum of $1,408.63, for the year 1912.

These power rights which were initiated, but not completed and in operation, before February 24, 1909, and those projects initiated between the above date, and May 22, 1909, are not covered by either of the power tax laws, and hence are exempt from the payment of annual license fees. The records show ten appropriations initiated under the 1909 water code, prior to May 22, 1909, for the development of 5,340 horsepower. It is impossible to ascertain the extent of the appropriations initiated, but not completed, prior to 1909, owing to the fact that only an incomplete record is available.

SURVEY FUND.

Provided for by Chapter 237, Laws of 1911, p. 419.

The license fees due and payable to the State on January 1, 1912, amounted to $3,550.86. This amount was collected from those water power plants where rights were initiated and some water used prior to May 22, 1909. This money has been paid to the State Treasurer and credited to the "Survey Fund" created by Chapter 237, Laws of 1911.

CONDITION OF FUND.

Power fees collected during 1912, under Chapter 237, Laws 1911			$3,550.86
	Services.	*Expenses.*	
Deschutes River Power investigations	$1,795.66	$1,221.99	
Columbia River Power investigations	250.00		
	$2,045.66	$1,221.99	$3,267.65
Balance unexpended December 1, 1912			283.21
			$3,550.86

In order to extend the work which could be accomplished with the Survey Fund, the State Engineer submitted a plan for co-operation to the Director of the U. S. Geological Survey with the result that the following agreement was executed.

AGREEMENT.

"In consideration of the mutual covenants and agreements herein set forth, it is mutually understood and agreed by the parties hereto as follows, to-wit:

"I. The State Engineer of the State of Oregon agrees to apportion and to expend on the Deschutes River profile and water power investigations, in co-operation with the United States Geological Survey, during the calendar year of 1912, the sum of Three Thousand Dollars ($3,000), which amount is to be paid from the Survey Fund created by Chapter 237, Session Laws of Oregon for 1911.

"II. In consideration of the above apportionment on the part of the State Engineer of the State of Oregon, the Director of the United States Geological Survey hereby agrees that upon the appropriation of funds by Congress on or about June 1, 1912, that the sum of Three Thousand Dollars ($3,000) will be apportioned by the United States Geological Survey for co-operative surveys and water supply investigations in the State of Oregon, said allotment to be expended during the fiscal year embraced between July 1, 1912, and July 1, 1913. The particular purpose for which the Government allotment is to be expended shall be mutually agreed upon between the parties hereto prior to the expenditure of any of such Government funds.

"Executed this 21st day of February, 1912.

(Signed) GEO. OTIS SMITH.
Director United States Geological Survey.

(Signed) JOHN H. LEWIS,
State Engineer of the State of Oregon."

Up to December 1, 1912, the United States had expended $1,700 under its agreement, and work has been outlined to consume the balance of the fund in accordance with the terms of such agreement.

SURVEYS FOR STREAM ADJUDICATIONS.

The State Engineer is required to make certain surveys and investigations in connection with water right adjudications by the Board of Control. These surveys consist of an accurate measurement of all irrigated land, location of points of diversion, ditches, canals, and power plants, all of which information is shown on maps presented at the hearings before the division superintendents.

Information as to the capacity of all ditches and the discharge of the stream and its principal tributaries, and presented in tabular form, is also secured. The data secured in this manner is of the greatest importance in determining the relative right, as it furnishes exact information as to the actual condition of every tract of land in the territory involved in the determination. No determination can be undertaken until the survey of the stream is completed.

During the past two years it has been possible, with the funds available, to have the survey of the various streams, under adjudication, completed just in advance of the time set for the taking of testimony by the superintendent and thus delay has been avoided, and it is believed that with a similar appropriation, the same condition will prevail during the ensuing two years.

The tabular statement below furnishes a summary of the work accomplished since the last biennial report. It will be observed that 241,817.95 acres have been surveyed as compared with 110,396.33 acres during the preceding two years:

Name of stream	Main canals		Acres irrigated	Townships covered	Cost	Cost per acre—cents
	Number diversions located	Length in miles				
Grande Ronde	352	249	20,299.45	31	$ 1,883 96	.09¼
Silvies River	251	246.25	77,566	29	3,282 60	.04¼
Powder River	782	910.53	88,694.9	52	5,534 54	.06¼
Rogue River (resurvey)	324	463	13,715.35	46	1,107 73	.08
Chewaucan River	134	72.1	28,690.25	19	551 91*	.019
Lost River	14	25.5	5,988	13	377 28	.063
Squaw Creek	----------	----------	†6,535	------	515 00	.078
Cherry Creek	3	5	225	1	122 52	.54½
Bechdolt gulch	2	4.5	104	1	40 00	.38½
	1,962	1,975.88	241,817.95	210	$ 13,415 54	‡.055

* The low cost per acre of this survey is due to the fact that it was done in connection with the Desert Land Board inspection, and a part of the cost was borne by such board.

† Survey covered only area to which incohate rights were granted by Squaw Creek decree.

‡ Average.

In addition to the foregoing surveys, additional data has been secured on Crooked River. It has been found necessary to have a representative of this office present at each hearing and contest held by the superintendents in order to render assistance in filing claims and explaining the maps and other data collected by this office. By this practice much confusion is avoided, as often a brief explanation by the field man familiar with the ground will convince the water user that the maps are correct, thus saving misunderstandings and expensive contests.

SIX THOUSAND NINE HUNDRED DOLLAR ADJUDICATION FUND

Appropriation for calendar year 1911 under Chapter 239.

Laws of 1911		$ 6,900 00
Services	$ 3,163 83	
Supplies	270 20	
Expenses	3,465 89	
Reverting to State Treasury	08	6,900 00

APPROPRIATION FOR CALENDAR YEAR 1912, $6,900.00.

Name of stream	Services	Expenses	
Grande Ronde survey	$ 902 22	$ 981 74	
Silvies River survey	675 66	570 85	
Powder River survey	1,237 28	934 13	
Rogue River survey	147 50	145 00	
Chewaucan River survey	46 77	116 60	
Lost River survey	125 00	71 70	
Squaw Creek survey	62 50	43 85	
	$ 3,196 93	$ 2,863 87	$ 6,060 80
Field equipment			351 75
Balance unexpended December 1, 1912			487 45
			$ 6,900 00

JUDICIAL INTERPRETATION OF THE WATER CODE.

The courts have been called upon to interpret the Water Code in three different cases, and a number of important rulings have been made.

In the case of Cookinham *v.* Lewis, 58 Or. 484, the Supreme Court of the State of Oregon has construed that portion of the law relating to the granting of permits as follows:

"It shall be the duty of the State Engineer to approve all applications made in proper form which contemplate the application of water to beneficial use, but where the proposed use * * * is a menace to the safety and welfare of the public, the appropriation shall be referred to the Board of Control for consideration. It shall be the duty of the Board to enter an order directing the refusal of such application, if, after full hearing, public interest demands."

The court held that an application which menaced either the safety or the welfare of the public could be referred by the State Engineer to the Board of Control, and that such Board could direct its refusal if public interest demands.

The question as to payment of water masters by the county was passed by the Supreme Court in the case of Wattles *v.* Baker County, 59, Or. 255.

A recent decision by the United States District Court for Oregon, as to the jurisdiction of that court, where citizens of different states were served with notices by the Board of Control in the determination of the relative rights to water from Silvies River (199 Fed. 495), has resulted in a number of important rulings. The case was transferred to the Federal Court upon a petition for its removal, filed by the Pacific Livestock Company, of California, and the opinion handed down upon a motion to remand, filed by the Attorney General, acting on behalf of the Board. The motion to remand was allowed on three different grounds.

1. That the Board of Control is not a judicial body, but rather an administrative body, having only subordinate judicial powers. Its duties are primarily administrative. Adjudication proceedings before the Board cannot be considered a "suit at common law or in equity" within the meaning of the removable statute until the findings have been entered and filed with the court.

2. That all claimants to the waters of a stream must present their claims to the Board of Control as provided by law, without regard to the fact that one or more of such claimants may be a foreign corporation, or resident of another state, as the cause is not one which can be decided by separate tribunals.

3. The court says, with respect to the last point, that "I am also impressed with the soundness of the view that a proceeding for the adjudication and determination of the rights to the use of the waters within the State, instituted and conducted as provided in the legislative act of 1909, is in effect a proceeding on behalf of the State through an administrative or executive board to have judicially settled *in an economical and practical way*, the rights of various claimants to the use of the waters of a stream or source of supply, and thus avoid the uncertainty as to water titles and the long and vexatious controversies concerning the same which have heretofore greatly retarded the material development of the State."

The constitutionality of the water code has not, as yet, been questioned in our courts. It is believed that the last case above mentioned, together with the Wyoming case of Farm Investment Company *v.* Carpenter (61 Pacific 276), and the

Nebraska case of Crawford *v.* Hathaway (93 Northwestern 795), settle, beyond question of doubt, the constitutionality of the law, as the Oregon court followed the reasoning laid down in the Wyoming and Nebraska cases which held similar laws to be constitutional. The Wyoming and Nebraska water laws are similar in many respects to the Oregon law, and are supported under the police power of the state to regulate streams to preserve the peace and safety of the people. It is not necessary that one be a water user to know something of the litigation, strife and bloodshed which annually occurs on many streams where no public administrative system is provided to distribute water.

NATIONAL QUESTIONS.

During the past year the State Engineer has had the honor of being invited to address two national organizations. In June, 1912, he discussed the question of State and National water laws before the American Society of Civil Engineers, at its annual convention in Seattle. The aid of this organization was sought in the solution of the interstate water problem. Where waters originate in other states, and flow into Oregon, it is impossible to protect our citizens from diversions in such upper states without some reciprocal agreement, or national aid. Inasmuch as this paper has been published in full, occupying 40 pages in the proceedings of this society for September, 1912, further discussion of this subject will not be presented here. Criticism of this paper will be found by any one interested in the proceedings for November, December and perhaps later numbers. The unfavorable reference to the Utah law, as presented in this paper, has already resulted in the State Engineer of that state visiting Oregon for the study of our laws with the view of recommending them for adoption in Utah, the pioneer irrigation state of the Union.

The question of co-operation between the State and Nation in irrigation and water power development was discussed before the National Irrigation Congress in August, 1912. This discussion, together with the conferences had at that time with government officials no doubt assisted materially in getting from the Secretary of the Interior his promise to recommend the appropriation of $50,000 for the survey of the Deschutes project, if the State would contribute an equal amount.

SPECIAL REPORT.

Owing to the frequent inquiries concerning the operation of our water laws, the State Engineer prepared in April, 1912, a

16-page pamphlet entitled The Oregon System of Water Titles and designated as Bulletin No. 2.

This publication has already resulted in a considerable saving in correspondence relative to this subject. Owing to the fact that the water law and its operation has been fully presented in this bulletin, no detailed explanation of the law will be presented here.

Copies of this bulletin are still available for distribution to those desiring such information.

STATEMENT OF EXPENDITURES.

Salaries and expenses of the office and department of the State Engineer.

1910—Balance unexpended December 1, 1910	$ 1,624.13	$	
Salaries of office force		$	1,260.00
Office supplies, expenses, etc.			309.11
Traveling expenses			45.82
Reverting to State Treasury			9.20
	$ 1,624.13	$	1,624.13
1911—Appropriation for calendar year 1911	$ 10,000.00		
Salaries of office force			7,654.02
Office supplies, expenses, etc.			2,236.97
Traveling expenses			108.50
Reverted to the State Treasury			.51
	$ 10,000.00	$	10,000.00
1912—Appropriation for calendar year 1912	$ 10,000.00		
Office supplies, expenses, etc.			1,614.73
Salaries of office force			6,373.49
Traveling expenses			242.06
Balance on hand December 1, 1912			1,769.72
	$ 10,000.00	$	10,000 00

EXPENDITURES COMPARED.

In order to give some idea as to relative amount of money appropriated by Oregon for the expenses of the office and department of the State Engineer, as compared with other states, where they have similar departments doing the same work, the following figures have been compiled:

	Expenses of State Eng. Dept. annually	Population of State	Area of State sq. mi.
Oregon	$ 10,000	672,765	95,607
Wyoming	12,300	145,965	97,594
Idaho	10,100	325,594	83,354
Nevada	15,000	81,875	109,821

The Oregon appropriation is barely sufficient to meet the ordinary running expenses of the department.

If any new duties are imposed upon the State Engineer, such acts should provide additional funds with which to carry out such duties.

ADDITIONAL FUNDS NEEDED BY BOARD OF CONTROL.

For the Years 1913 and 1914.

The present appropriation for the work of the Board of Control has proved greatly inadequate, and in order to complete the vast amount of work already undertaken by the Board, and to take up other work which has been postponed on account of lack of funds, it will be necessary to hire additional field and office assistance during the years 1913 and 1914. The taking of testimony in connection with contests in stream adjudications undertaken by the Board involves a large expenditure, as each contest practically constitutes a suit, necessitating the calling of witnesses and expert testimony. Approximately 185 contests have been initiated in connection with the Rogue River determination, 200 on the Umatilla, 300 on Powder River, 100 on Silvies River, 100 on Grande Ronde, and from forty to fifty contests are likely to occur in the determination of the rights to the use of the waters of Lost River and Cherry Creek in Klamath County, and Chewaucan River in Lake County.

In addition to these contests, the Board of Control must make field investigations as to the completion of rights acquired under permits issued by the State Engineer. No water right certificates can be issued such permit holders until after a field inspection by a representative of the Board to ascertain by survey the extent to which public waters have been applied to beneficial use, and therefore vested. These people have paid their fees and are entitled to final certificates. Over one thousand permit holders have completed their appropriations and are anxious to receive final certificate, which is evidence of their title to water. In some instances these certificates should have been furnished over a year ago, but owing to the insufficient funds at the disposal of the Board, the necessary field examination could not be made at that time. It has become imperative, however, that these examinations be made during the coming year, hence the necessity of hiring a competent surveyor to take charge of this work in each division. As these projects are scattered over a large territory, and many are in remote parts of the State, the time and expense involved will be considerable.

In addition to these examinations, proof must be taken as

to the completion of inchoate rights granted in the Tumalo Creek adjudication, in Crook County and on other streams as the dates for completion expire.

The following budget has been prepared, setting forth the annual expenditures which this additional work will involve, during the years 1913 and 1914.

Expert field stenographer for taking testimony in contests	$ 1,200
Expenses of such stenographer	900
Salary and expenses of assistant stenographer when required	1,500
Two engineers for making field investigations at $1,800	3,600
Expenses of field man at $1,000	2,000
Additional clerical assistance needed in office of Board, and by division superintendents	900
Total for year in addition to present appropriations	$ 10,100

With increased funds, the present board can accomplish much additional work, as it can work more efficiently. Three members on this board are sufficient to direct this work. If there is any strong demand for greater speed in adjudications, more help and more money should be allowed the present Board instead of additional high priced superintendents.

NEEDED LEGISLATION.

In the framing of the water code, many important features were omitted in order to shorten the Act and to overcome to that extent the difficulties in securing its enactment. It was thought that such additional features could be secured at any subsequent session of the legislature.

Although a number of definite recommendations were made in the last report of this office, practically no advance was made at the last session.

No changes in the fundamental principles of the law should be made, but it is recommended that legislation be had on the following points, arranged in order of their importance.

RECOMMENDATIONS.

(1) Provide additional funds for the Board of Control so that the two superintendents can be kept working to their full capacity, as outlined in detail above.

(2) Provide for the detailed investigation of one or more irrigation and power projects, the cost to be made in lien upon the district through water right withdrawals, and ultimately returned to a revolving fund for the investigation of new projects.

(3) Provide that all water used in this State for any and all purposes, shall remain appurtenant to the place of use.

Only water for irrigation is so made appurtenant under the present law. This matter is fundamental. The system of records is based upon keeping track of the place of use. There can be no stability of water titles where water can be shifted at will from one place of use to another, without proper notation on the records at Salem.

(4) The Legislature should declare the beneficial use of water to be a public use and benefit.

You can condemn only for a public use. What is a public use is a matter for decision by the courts in each case, and it may be held that the condemnation of land by an individual for right of way to put water to beneficial use is not a public use or benefit. A statutory declaration will settle this uncertain question. It is a great public benefit to have our unappropriated waters put to use for irrigation and other purposes. The small appropriations in the aggregate far exceed in value to the State, the large spectacular projects, and it is for this reason that every encouragement should be given to individual effort. According to the recent census, 82% of the increase in irrigated area during the past ten years was accomplished by individual effort. The individual is entitled to the same right of condemnation as a corporation.

(5) Provide for the submission to and approval of detailed plans by the State Engineer for all dams over 10 feet in height, and inspection by a representative of the State during progress of the work.

The great loss of life at Austin, Pennsylvania, through the failure of a poorly-designed dam, has served recently to call attention of the public to the importance of some public authority passing upon the adequacy of design prior to construction. A number of complaints have already been made in Oregon to the State Engineer, but no relief can be given under present law. The spillway of an earth and rock-fill dam is said to be inadequate to carry the maximum flood. Three high earth dams are in process of construction where the usual precautions in preparing foundations have not been taken and in one of which cases, a timber outlet conduit is built through the dam itself. Decay of these timbers means destruction of the dam with possible loss of life. The public has a vital interest in these matters, and those living below any such structure have a right to know that it is actually built according to such approved plans.

(6) Legalize the rotation of water under permits granted by the State Engineer. An appropriator should have a right to take twice the amount of water allowed him for half the time in order to irrigate his land more quickly and economically,

provided he arranges with some one else to exchange with him, each using the combined supply part of the time.

(7) Provide for the exchange of water between canal and reservoir owners where no injury can come through such exchange.

The first canals and reservoirs built on a stream are invariably the cheapest. Often the lands watered therefrom can be reclaimed from some other source though at greater expense, and by so doing, a transfer of these early rights to lands higher up on the stream might be made, thus bringing about the reclamation of a much larger area. Most arid states authorize such exchanges of water as a matter of public policy. Oregon should do so likewise, provision being made for the protection of the present owners of early rights.

(8) Provide that three years' non use of water shall be abandonment.

It is very difficult to prove abandonment under the present law because it is a question of intent. Two years is perhaps too short a time. The law should be changed to make non-use for three consecutive years to be abandonment, and proof of such fact should work a forfeiture of the right. With beneficial use as a basis of the right, such a statute is necessary.

(9) Require the State Engineer to limit all permits for irrigation purposes to beneficial use, not to exceed a rate of one cubic foot per second for 80 acres.

The State's surplus water supply is limited. This water is of growing value. To grant twice the amount of water necessary for economical use will reduce by one-half the ultimate benefits to be obtained. Other states legislate on this question. In Canada, one second-foot is allowed for 160 acres. In Wyoming, one to 70 acres. One to 80 acres is reasonable for Oregon, and has been so recommended by leading authorities on irrigation. No greater amount of water has been allowed for irrigation purposes in permits granted during the past four years. An unscrupulous administrative officer could do much injury to future development by excessive grants.

In order to get the sentiment of actual water users on a number of the foregoing recommendations, a circular letter containing definite questions was sent out with the request that those interested reply thereto, in order to give the administrative officers the benefit of their combined wisdom. In all, 441 replies were received. The questions asked were as follows, which are numbered to correspond to the recommendations listed above:

(3) Do you recommend the making of all water used in this State for any and all purposes appurtenant to the place of

use, so that the water records at Salem may be complete and reliable?

(4) Do you favor a legislative enactment declaring the beneficial use of public water to be a public use and benefit, so as to enable anyone to condemn necessary right of way for ditches and pipe lines?

(5) Do you believe that plans for the construction of dams should be approved by the State authorities prior to construction?

(6) Do you favor legalizing irrigation by rotation, that is, using a large head part of the time instead of a small head flowing continuously?

(7) Do you favor providing by law for the exchange of water between canal and reservoir owners, so that the highest development may take place?

(8) Do you believe that three years' non use of water should work an abandonment of the right?

(9) Should the State guard against possible extravagance in future water grants by enacting that not more than 1 cu. ft. per sec. shall be allowed for the irrigation of 80 acres? (This limitation will not apply to vested right.)

(10) Have you ever had any trouble with your neighbors over a proper distribution of your water supply, prior to the adjudication under the new law, if any has so far been made?

A summary of all replies to the foregoing questions is as follows:

Summary of Replies—Total 441.

Question No.	Total number answering questions	Number answering		Per cent of total answering	
		Yes	No	Yes	No
3	436	421	15	96.55	3.45
4	420	355	65	84.5	15.5
5	425	401	24	94.3	5.7
6	412	356	56	86.2	13.8
7	399	368	31	92.2	7.8
8	423	349	74	82.5	17.5
9	415	377	38	90.9	9.1
10	394	92	302	23.3	76.7

From this it would appear that about 90% of the water users who were sufficiently interested to answer these questions were in favor of the enactment of recommendations 3 to 9 inclusive, and that approximately 10% were opposed to such recommendations.

Respectfully submitted,

JOHN H. LEWIS,

State Engineer.

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